FRIDGE SPACE:
JOURNEYS OF THE
DOMESTIC REFRIGERATOR

by

HELEN WATKINS

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ABSTRACT

My dissertation emerges from a curiosity about the mundane objects and machines with which we live and it pauses in Britain's kitchens to ask what we might learn from looking in the fridge. Considered by many to be a rather ordinary and unremarkable appliance, the refrigerator forms a virtually ubiquitous backdrop to routine activities of feeding, provisioning and storing, but rarely is it brought into explicit focus.

This study traces the 'career' of the mechanical refrigerator and is based upon interviews and archival work in Britain. I unravel intersecting histories and geographies of cooling, discuss a global trade in ice, explore changing understanding of the nature of heat and cold and show how varied ideas and technologies contributed to achieving the creation of artificial cold. The means by which these techniques were translated into the home is central to my discussion and I show how the domestication of refrigeration also played a role in the reconfiguration of associated practices, such as freezing, shopping and eating. I consider the process of normalisation through which refrigerators shifted category from novel products to essential appliances and argue that in many ways the refrigerator has now become integral to the constitution of domestic space.

My research follows the lifecourse of the refrigerator and its journeys through multiple sites and spaces, enabling me to analyse diverse refrigerator knowledges and practices from repair shops and recycling facilities to scrap yards and museums, in addition to the home. Although using a refrigerator is frequently dismissed as something 'self-evident' or 'obvious,' I argue that fridge practices are not innate but learned. I explore ways in which these knowledges travel and pay particular attention to the translation of scientific and technical knowledges into domestic contexts. The 'reach' of the domestic refrigerator is considerable and I use one of the more notorious moments in its career, when refrigerators were implicated in global climate change, as a way to show how day to day activities like chilling milk and lettuce can have far-reaching effects at a range of scales.

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LIST OF ACRONYMS AND ABBREVIATIONS

BAS	British Antarctic Survey
CFA	Chilled Food Association
CFC	Chlorofluorocarbon
cu ft	cubic feet
CVC	Central Valuation Committee
DEFRA	Department of Environment, Food & Rural Affairs
DETR	Department of Environment, Transport & the Regions
DoRDeC	Domestic Refrigeration Development Committee
DTI	Department of Trade & Industry
EAW	Electrical Association for Women
ECD	Electron Capture Detector
EDA	Electrical Development Association
ELF	end-of-life fridge
ENDS	Environmental Data Services
EPA	United States Environmental Protection Agency
EWC	European Waste Catalogue
FDF	Food and Drink Federation
FISS CGW	Food Industry Sustainability Strategy Champions' Group on Waste
FFRC	Food Freezer and Refrigeration Council
FFSS	Food: From Source to Salespoint
FSA	Food Standards Agency
GEC	General Electric Company
GHS	General Household Survey
HoC EFRAC	House of Commons Environment, Food & Rural Affairs Committee
IFT	Institute of Food Technologists
ISFT	Institute of Food Science and Technology
LEB	London Electricity Board
MAF	Ministry of Agriculture & Fisheries
MAFF	Ministry of Agriculture, Fisheries & Food
MMB	Millennium Memory Bank
MOA	Mass Observation Archive
MoWL	Museum of Welsh Life
MP	Member of Parliament
n.d.	no date
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
ODS	ozone depleting substances
RICA	Research Institute for Consumer Affairs
rpm	revolutions per minute
THP	Temporary Housing Programme
UNEP	United Nations Environment Programme
UV	ultraviolet
WGPW	Women's Group on Public Welfare
WMO	World Meteorological Organization

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Chapter 1

Introduction:

refrigerators, practices, knowledges & journeys

THE WEEK IN THE WINDOW

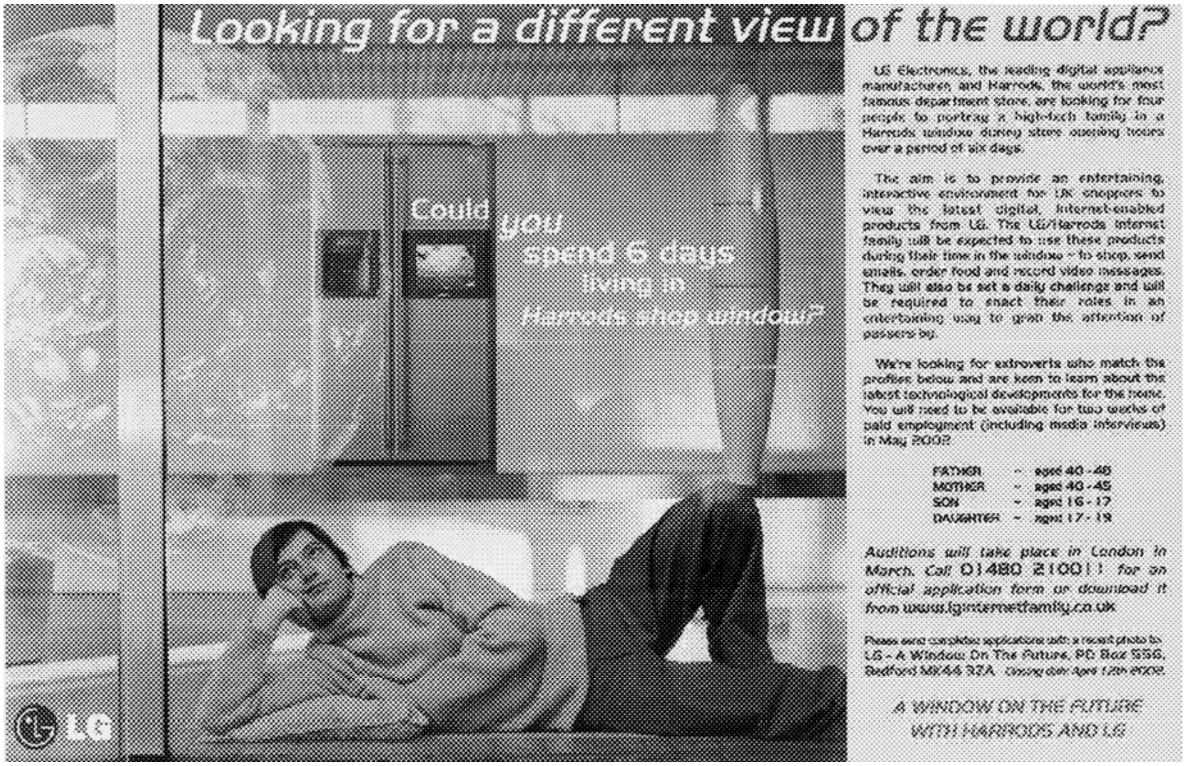
Had you been making your way along London's Brompton Road on Monday May 20th, 2002, or any day that week, your eye might have been drawn to a crowd of people clustered around the window of Harrods (Figure 1.1). If curiosity had got the better of you, you may have felt inclined to manoeuvre your way through the throng to take a closer look at whatever was attracting such attention. There you would have gazed upon "The Window On The Future," as they called it – a marketing promotion concocted by LG Electronics, a South Korean electronics manufacturing giant, and Harrods, a one-time grocer's shop from Stepney and now probably the world's most famous department store. And what would you have seen in, as it were, 'The Future,' had you peered through the window that day in May?

Figure 1.1 Curious onlookers, Harrods, May 2002

Inside, looking out, were two families. One had arrived in the window as a result of an advertising campaign inviting applicants to audition for the roles of the mother, father, teenage son and teenage daughter in 'The LG Internet Family.' "Looking for a different view of the world?" LG's ads enquired. "Could you spend six days living in Harrods' shop window?" (Figure 1.2). Their task for that time in the window was to draw attention to the other LG Internet Family, this one the first 'family' of networked domestic appliances to be launched into the UK market. Forty finalists were invited to audition, twelve were shortlisted and members of the public voted online to select the final four, which is how Sarah, Carl, Steve and Charlie came to claim their 'fifteen minutes of fame' by sharing Harrods' storefront with a washing machine, microwave oven, air conditioner and fridge.[1] Smart, sleek, sexy and positioned centre-stage was the fridge: £6000-worth of multi-media internet-enabled fridge, to be precise.

1 The advert ran in The Evening Standard, The Guardian, Time Out and The Stage. LG claims that 6 million people read or heard about 'The Search for the Family' and around one thousand people entered the competition. The judges included an actor and theatre director, a reporter and documentary maker and an entertainment producer involved in events such as Big Brother and Miss World, along with Harrods' Events Marketing Manager and LG's Technical Product Manager. The four family members selected were Sarah Wooster, a 41-year-old counsellor, Carl Newman, a 40-year-old sales consultant, Steve Wilson, an 18-year-old radio presenter and Charlie Parker, a 17-year-old student. In one interview, Sarah commented: "I'm probably half-way through my life and haven't had my 15minutes of fame yet – I think this could be it."

Figure 1.2 Advert for the LG Internet Family



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The family 'went live' that Monday at 10am when Harrods owner Mohammed Al Fayed lifted the blinds to reveal four "live mannequins" who would spend the week living in public view.[2] Al Fayed was delighted by the promotion. "I think it's a fantastic idea," he said, "just like theatre" (www.lginternetfamily.co.uk).[3] And theatrical it certainly was. No pretence was made that this represented an average week in a typical British home, what with the designer clothes and daily makeovers, the constant press and webcam coverage, the visit from the Korean Ambassador and the regularity with which celebrities (such as the World Snooker Champion, members of the Riverdance troupe and contestants from the television show *Big Brother*) dropped by to set the family challenges, not to mention the family's energetic daily

2 Prior to the week, LG had held a media launch for press and television crews and a trade event for kitchen specialists, architects, designers, property developers.

3 All quotations not otherwise referenced are taken from LG's website www.lginternetfamily.co.uk, which provided extensive coverage over the course of the week.

rendition of the LG song – in Korean.[4] Their Harrods 'home' consisted of four room sets, a kitchen, a living room, a leisure area and a spa and relaxation area, filled with designer furniture, electronics and appliances. Fully functional as 'stand alone' appliances, each of the products in LG's networked home appliance range can access the internet via a laptop computer to download programme upgrades:[5]

> However, to obtain the full benefit and capability of the Networked Appliances they must be connected to each other … in order to communicate and offer remote access. … The main consumer benefits are that you have full access to your digital appliances in the office or when using your mobile phone – so you can turn your washing on, download a Thai chicken curry Microwave recipe or cool your home down at the touch of a button. … You can surf the net, check or send emails and do your shopping while preparing or eating a meal (http://www.lginternetfamily.co.uk/homenetwork.asp)

The GR-D267DTU Digital Multimedia side-by-side Fridge-Freezer is described as the 'lynch-pin' of the family because contained within it is the server that enables all the appliances to 'talk' to one another. Coupled with a mobile phone, the fridge enables various household functions to be controlled from virtually anywhere and it also collapses space to 'bring the world' into the kitchen. Alongside a dispenser for ice cubes and iced water, the fridge door boasts a 15-inch touch-screen communication interface:

> Watch TV, listen to music or surf the internet using this titanium finish, state-of-the-art fridge freezer. It's the ultimate in kitchen technology with a built-in MP3 player for downloading and playing music from the internet, e-mail and video mail using a built-in camera and microphone. It even has full internet access so you can re-stock the refrigerator on-line or check on the latest news and weather, all without leaving the kitchen (http://www.lginternetfamily.co.uk/homenetwork.asp).

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4 *Saranghayo Saranghayo Saranghayo LG,*
Urimodu Oosoby-yo Mee-rayay Olkulo Arum,
Do-win Uri sa-rang onsae san-ge Pozi ri,
Saranghayo Saranghayo Saranghayo LG

which translates as:

I love you, I love you, I love you LG,
Let's smile together in the face of the future,
Our beautiful love is spread out all over the world,
I love you, I love you, I love you LG

5 This move acknowledges that technologies are never 'complete' but continue to evolve and change. The ability to download updated software builds into these machines the potential to assume capacities that have not yet been developed or possibly even imagined.

“And it’s great for storing food too,” the webpage adds, as well as providing a recipe database and nutritional fact file, electronic maintenance manuals and the capability to self-diagnose minor faults on-screen. Ever-present and always on, this fridge, with its voice mail, video mail and on-screen text messaging, becomes a site for interaction between often-absent others. Apparently, it can even recognise your handwriting – though for all its impressive gadgetry, it manages to score only a ‘B’ rating for energy efficiency. Its claim to monitor food contents and expiry dates also turns out to be more ‘low tech’ than it sounds for it involves manually entering each item and its storage period into a database, after which the fridge counts down the days.[6] Nevertheless, this is a fridge that does much more than simply chill your milk. With its host of built-in entertainment and communication features, this product seeks to re-imagine the role and rationale of the refrigerator.

My purpose in presenting the scene in Harrods’ window is primarily to put the refrigerator centre stage as an explicit focus of attention, just as was LG’s intention, and also to suggest that looking at the fridge can indeed offer a different view of the world. The promotion caught people’s eye because it showed household appliances in a context where they would not ordinarily be seen. This dissertation attempts to do the same. Both are deliberate strategies to arouse the curiosity of the viewer, reader or the passer by, to try and make them stop and wonder and to encourage them to see familiar things from a fresh perspective. I position a seemingly mundane household appliance as an object of a detailed academic study – an unexpected location for a fridge. In doing so, I propose that refrigerators and refrigeration can be rich and revealing subjects whose study can offer insights into knowledges, practices and people’s relationships with things.

“The Week in the Window” was intended to depict a family “living and managing their lives with the help of LG’s range of networked appliances” (Figure 1.3). LG wanted to convey the message that the products were stylish, interactive, entertaining and easy to use. As more complex versions of technologies with which people are familiar, locating them in a setting that, though somewhat stylised, is recognisable as ‘home’ helped domesticate them. They are similar enough to seem accessible but different enough to capture one’s attention.

6 Technology for automatic barcode scanning is in development but not yet on stream.

“Demonstration of the new technology and its capabilities is key,” emphasised LG’s Sales and Marketing Director John Lougher. A crucial element of the family’s role was therefore to perform product demonstrations, including “regular interaction with the fridge screen,” on the principle that certain knowledges are best communicated through action (Figure 1.4). Showing is a powerful way of teaching and people can learn a lot about a product and its capabilities by watching others use it. That said, the focus on performing the mundane practices of daily life was limited. Relatively little was done in the way of household labour, food management or routine preparation of meals; indeed, the press release announcing that LG Electronics’ ‘mother’ had won her place in Harrods’ window noted that Sarah “will avoid the traditional mother’s role of cooking as the family’s food will be prepared by top chefs and brought into the ‘house.’”[7] Certain tasks did involve using the appliances (such as making a Sunday lunch, washing laundry or downloading a recipe to cook in the microwave), but for most of the challenges they were marginal at best (like when it came to playing snooker, dancing in a wig, creating play-dough models of the viewers watching through the window or making window boxes blindfolded!). These became pure spectacle. Thus, the knowledges being communicated were not simply practical tips on how to operate these appliances but also the ‘knowledge’ that they were desirable consumer objects associated with leisure and enjoyment. Marketing involves subtly educating people to be good consumers and suggesting that they should be using, or aspiring to use, products of this kind. Life, it appears, would be richer, easier, more organised – and certainly much more fun – with one of these.

7 http://www.lginternetfamily.co.uk/press/sarahwoosterwins.pdf

Figures 1.3 & 1.4   The Internet Family in the kitchen using the refrigerator

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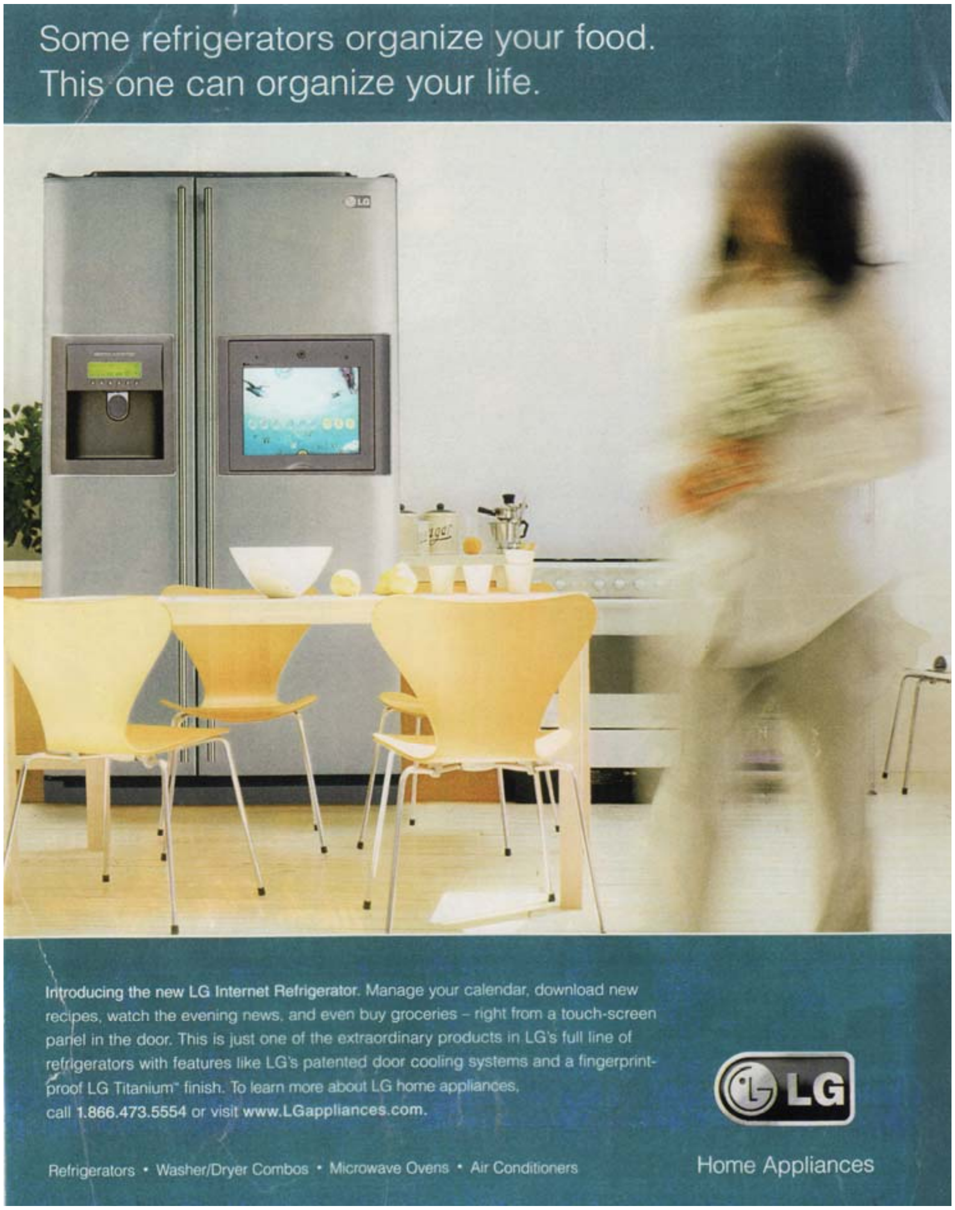
The domestic 'future' depicted in the window was a playful one, far more focused upon leisure than on labour. Here, the fridge makes music and grocery shopping is something done online while one cooks or eats. It is quick. It is simple. It is barely work. The shape of the appliances (and the nature of the leisure activities) may have changed, but the message is nothing new. In a trope familiar throughout the history of appliance advertising, their promotion does not speak of 'work' so much as its removal by machines. The ability to perform the work of organising, as well as cooling, is explicitly attributed to the fridge in LG's parallel magazine advertising campaign (Figure 1.5).

Figure 1.5 LG magazine advertisements, 2003



Given that the target markets for this appliance range are the 'rich' and 'super-rich' demographics, along with 'early-adopters,' designers and architects, Brian Williams, LG's Technical Product Manager, told me in an interview that LG did not expect the Harrods launch to generate mass sales. The exercise was more of an investment in brand awareness, one aiming to generate a high level of publicity, to associate LG's name with innovation and to represent the company as having 'a vision of the future.' At the end of the week the Sales and Marketing Director commented that:

> The LG Internet Family was compulsive viewing … We are delighted with the public and media response. LG is now firmly on the map and the public now knows just what we – and our appliances – are capable of.

This conceptualises the audience's act of looking as simultaneously an act of mapping, for to be known is to be located 'on the map.' In essence, marketing is all about increasing 'mindshare,' that is, the prominence with which brands are positioned in people's minds or how much mental space they occupy. Thousands of shoppers and passers-by watched the spectacle through the window and the official London tour bus was even rerouted specially for the occasion, but physical proximity was not a prerequisite to witness 'The Week in the Window.'[8] Extensive media coverage turned it into a global affair. The four gave numerous television, radio and press interviews and two dozen countries across Europe and from the United States, South Africa and Japan to Korea and Kazakhstan featured footage of the 'Internet Family.' Viewers could also take virtual tours of the home and watch live webcam broadcasts on a website (www.lginternetfamily.co.uk) that received four million hits during the course of the week (so even if you had not been heading down the street that week, you need not have missed the fun).[9] The intention was to bring both families into hypervisibility, piggybacking one upon the other in their store-front 'home.' "The actor in me can't wait to step onto the Harrods stage" said Steve, the 'son,' before the launch, "what a thrill to be watched for six days. … I hope I also get into the papers and onto TV." In a curious melding of marketing, reality TV, product placement and pantomime, the LG Internet Family performed 'family' and 'domesticity' with and through technology in front of audiences on Brompton Street and beyond.

Fascinating though the Internet Fridge might be, this dissertation is not a detailed study of 'smart' fridges, though it is about living with machines, about developments in household

8 Harrods' figures indicate that 30,000 shoppers visit the store each day and 175,000 people pass the windows each weekday, with closer to 225,000 on Saturdays.

9 The week was heavily plugged as an 'interactive' event in which the public could participate in the event, though participation consisted mainly of selecting the final four and then voting on 'twists' to make the daily challenges more amusing (such as performing them blindfolded or wearing wigs!). A strong incentive to participate was that all those who voted online were entered into a prize draw to win the appliances in the window, together worth £10,000.

technology and about domestic practice.[10] I am less concerned with the specificities of what happens when one fuses a fridge and a computer, or refrigerates one's food in public view, than with how this kind of melding or exposure might prompt us to re-examine our assumptions about the purpose and significance of the refrigerator. The Internet Fridge is a distant relative of simple wooden chests in which food was cooled by placing it alongside blocks of ice, which raises the question for me of how exactly we got from there to here. There was no inevitability about this trajectory, no guarantee that household appliances would eventually evolve internet capabilities. More to the point, it was not inevitable that fridges would catch on at all or end up as integral components of British homes. When I asked my interviewees whether a smart fridge would be of interest to them, some were astonished that such a thing existed and few imagined it being an appliance they would want, need or be willing to pay for. Some sounded curious to play with one for novelty's sake, but most had difficulty envisaging it having a meaningful role in their day to day lives. The fascinating point here is that had my interviews been taking place in the 1930s, or even the 1940s or 50s, the same might have been said about the 'conventional' household refrigerator – a fancy gadget and all very nice if you had the money, but not something for which most people saw a pressing need.

The LG fridge was a hit with the Internet Family. At the end of their week in the window, three of the four chose it as their favourite product.[11] Charlie commented: "I liked playing with the internet fridge, … I mean, it's just great, it's huge and can, it seems, do just about everything." When I visited Harrods' appliance department a year or so later and asked about sales of the Internet Fridge, a sales assistant commented wryly that lots of people came in to 'play' with it, but no one was buying. The fridge was evidently positioned in the category of 'toy,' rather than having the status of a 'tool' (Pantzar 2003), and it is hard to predict whether or not it will eventually be something Britons feel they 'need.' The fridge was also Carl's favourite product: "without sounding geekish, it's very sexy. Its titanium finish, its use of space, I love it." Steve agreed: "my favourite has to be the fridge. I love its

10 For a more specific focus on the internet fridge, 'smart' appliances and the networked home, see Kristina Marcellus's doctoral research in sociology at Queen's University in Canada (Marcellus 2005).

11 Sarah opted for the washing machine instead, wishing she had had one when her own children were small.

aptitude to be a fridge one minute, a music player the next and then receive my emails as well.” The family members were enamoured by its stylish appearance, versatility, multiple identities and ability to disrupt their preconceptions about what a fridge should look like, what a fridge should sound like and what a fridge should do. Steve’s notion of an object’s ‘aptitude’ to be a fridge provoked me to think more about what might constitute the inherent properties of ‘fridgeness,’ to ask where preconceptions about refrigerators come from and to explore how these have settled into common understandings of a refrigerator’s qualities, its capabilities and the ways it should be used. For me, the presence of this hypervisible refrigerator – centre stage within a home made-public – serves to raise a series of question that underlie this dissertation: Where did refrigerators come from and how did they get into the kitchen? How and why have they become commonplace, necessary and normal? How do people learn to use them, and learn to live with them? How have they influenced practices of feeding and provisioning? How do they work? What work do they do? What happens when they stop working? How have they become so present yet also so invisible?

FOREGROUNDING THE FRIDGE

My dissertation tells a story about people, objects, ideas and the entanglements between them. I explore the spatial reorganisation of cooling, the domestication of cold and the ingredients – conceptual, technical, material and political – from which the refrigerator was built. I am interested in how refrigeration technology was variously imagined, made material and modified; how the role and status of the fridge, and people’s relationships with it, have shifted over time; and not only how refrigerators move into the home, but also where they travel to thereafter.

My research is on the refrigerator in Britain, or at least that was my intent. However, the refrigerator, in its making, strays. It rapidly became clear that the fridge histories and geographies I want to tell refuse to stay neatly contained within national boundaries. Instead, they spill with some regularity into other parts of Europe, navigate the crossing to Australia, New Zealand and South America, make their way to West Africa, venture on more than one occasion to Antarctica and, above all, insist on repeatedly returning to the United States.

Therefore, while my focus stays on Britain, it does not remain exclusively so. This is not a comparative study so much as one that centres primarily on Britain but travels elsewhere too, and in so doing demonstrates the diversity of people and places implicated in its histories of cooling.

For an object now so integral to contemporary British kitchens, the domestic refrigerator is a surprisingly recent innovation, historically speaking. The very first mechanical refrigerators for domestic use were developed just before the First World War, but it was not until some decades later that they became a common fixture in the home. My parents bought their first fridge when I was born. They were part of the wave of adopters at the close of the 1960s and into beginning of the 1970s who finally nudged national fridge ownership into the majority. It is therefore only within my own lifetime that the refrigerator grew ordinary. It is easy for those of my generation and later to slip into the assumption that things like refrigerators or cars or washing machines have always been the norm. As Pantzar (2003) points out in his analysis of the cognitive work required for that which is novel to be made normal, it is not customary to question whether or why such things are necessary, or how that necessity came into being. As seemingly ubiquitous appliances in contemporary Britain, refrigerators grew into such familiar objects that they rarely intrude into one's consciousness, that is unless they misbehave, for often it is only when tools or equipment break down that they draw attention to themselves (Verbeek 2004, p. 79-80). Generally, we fail to notice the ways in which they are actively accommodated into our lives and our kitchens (Gregson 2006). My aim is to peel away the patina of ordinariness built up with age and familiarity and, for a moment, to approach the fridge as a point of focus in its own right, rather than as background (Goffman 1959).

Key themes

Emerging from the Week in the Window, with a refrigerator at its heart, are six key themes which thread through the chapters in this dissertation. The first two are the intertwined conceptions of 'refrigerator knowledges' and 'refrigerator practices.' I am interested in a variety of fridge-related knowledges and know-how, ranging from the work of observation, theorisation and practical experimentation to the acts of guesswork and imagination that underlay the invention and development of refrigeration and also shape its day to day use. I pay attention to ways in which knowledges are produced and organised and ways in which they move. I focus the process of learning how to use a fridge, which raises questions about the knowledges it requires or assumes and also those that it displaces. In turn, this leads me to consider intersections between 'scientific,' 'technological' and 'domestic' practices and knowledges and the extent to which these map onto particular spaces. My primary interest could perhaps best be thought of as 'spatial object-knowledge practices,' a slightly clumsy term, but one seeking to encompass the multiple intersections around which my study took shape.

A preoccupation with material objects and machines forms a third strand. My research stems from a curiosity about how we cohabit with our things, how we make and use them, mend them and discard them, or creatively appropriate them for purposes for which they were not intended. The roles of objects as carriers of knowledge is central here, and I look at the circulation of ideas through things like lumps of ice, ships, sides of beef and chemical refrigerants as well as through written texts like patents, instruction booklets or personal correspondence between friends, colleagues or collaborators. Though there are many sites and spaces caught up in this story, domestic space is my point of departure and the place to which I repeatedly return. My fourth strand focuses on domesticity and the objects, technologies and practices out of which this space is made. I am interested in refrigerators as technologies but principally in them as *domestic* and *domesticated* technologies. Even when my discussion roams into shopfronts, museums, cargo holds, laboratories or scrap yards, practices like storing and transporting food, performing demonstrations, reading manuals or throwing things away help knit these sites together with domestic spaces.

The fifth strand plays upon ideas of scale and (hyper)visibility. I suggest that, in many ways, refrigeration emerged out of an ability to see the world at a new scale. In turn, it enables us, perhaps even compels us, to engage with the world at different scales. The rationale for refrigerating food stems from an awareness that bacteria exist on a microscale, invisible to the naked eye, whilst the availability of artificial cooling makes possible a global trade in perishable foodstuffs. Refrigeration was used first in industry. Domestication involved a physical process of scaling down the technology, but it also depended on a shifting perspective in order to see potential applications at the scale of the domestic. It is also evident that 'small' things can have 'big' effects. The refrigerator's ability to control temperature artificially arises from manipulating gases and liquids in pipes just a few millimetres across. One effect of the widespread use of refrigeration and air conditioning has been to enlarge the proportion of the world considered habitable; another has been at once molecular and global as chemical reactions triggered by substances in refrigerants have been implicated in global climate change.

Lastly, I frame my account around 'journeys.' I have various kinds of journey in mind, which between them evoke the multiple forms of mobility and mutability that my dissertation deals with. Some take the form of material movements of physical objects, such as the import and export of blocks of ice, sides of mutton or refrigerator cabinets across national borders. Others involve the journeys of ideas and explore ways that knowledge spreads, ways that people learn or the evolution of competing bodies of ideas. The lifecourse of the refrigerator itself, in its passage through stages of design, production, use, disposal, destruction or preservation, represents another kind of journey, as does its conceptual movement through categories of meaning and value, such as its transition from luxury into ordinariness, or its transformation from commodity to waste. In parallel are my own journeys into different bodies of ideas and through diverse research sites on the trail of the refrigerator in British kitchens and beyond.

As to how I went about my research, my approach was principally one of following: following the fridges, following the evolution of ideas about cooling, following shifts in social practice, following the paper trails. This was, in part, an intellectual journey, but also a bodily one. I travelled by plane, train, van, foot and forklift truck. I encountered old fridges, new fridges, working fridges, broken fridges, fridges crammed with food and retired fridges held in perpetuity for the nation in museum collections. I found myself in many recognisable repositories of knowledge – the museum, archive, library, manufacturer's headquarters – but also in more unexpected sites of knowledge production, such as the van, dump, warehouse or kitchen. I talked to dozens of people about their connections with refrigerators, both professional and personal, and was grateful to have been welcomed into so many people's homes. In addition, there were many vicarious journeys. Some I was relieved not to be partaking in, such as early experimental transatlantic crossings with failed refrigeration systems and cargos of rotting meat, but others sounded much more entertaining and although I did not personally hitchhike round Ireland with a fridge in tow as the result of a drunken bet, I interviewed a man who did.

Round social theory with a fridge

> Something else looked briefly promising. This was called 'Theory' and it was just coming in. The point about Theory was that it didn't matter if you read *Jane Eyre* or a fridge installation manual: what you were doing was studying how you studied them, and the important thing now was not the (anyway, unquantifiable) 'value' of the original work but the effectiveness of the theory (Faulks 2008, p. 24)

A fridge makes for an unconventional travelling companion. Tony Hawks might have been the '*eejit*' hitching *Round Ireland with a fridge* (1998), but I was the person hauling a household appliance with me on my journey through various academic literatures. Below I sketch out some of the literatures which have informed my own refrigerator knowledges. Wanting to roam widely, I try to travel light by drawing upon the wealth of secondary literatures in a way that is suggestive rather than comprehensive. This is not intended to be a highly theoretical dissertation. I like to think of theory as a set of sturdy and supportive undergarments that quietly provide important shape and structure but do not intrude unduly into the way the narrative hangs. That said, a host of ideas have profoundly influenced my thinking and many are present in the making of this dissertation, in my ways of ordering and writing, just as much as in the text.

Inevitably, I had to be selective about the directions I pursued. While I discuss the early industrial applications of refrigeration as a precursor to its household use, I chose to concentrate upon domestic refrigeration and to touch only very lightly upon contemporary commercial or industrial contexts. Likewise, although I trace the development of the mechanical refrigerator in order to chart its progress into the home, my purpose is not to explore detailed questions of design (though see Nickles 2002; Forty 1992; Parr 1999). I make no attempt to try to cover marketing or advertising in any comprehensive way, though various examples of advertisements do make their way into these pages. Manufacture is another important area I allude to only briefly. This was mainly because most refrigerators in Britain are now imported. Production has shifted to Turkey, Eastern Europe and, increasingly, China, which would obviously have limited the scope for me to visit manufacturers to see the production process 'live.' By choosing to focus my attention 'downstream' instead, upon the later stages in a product's life, I was able to see the processes of repair, recycling and disposal at first hand in workshops, scrap yards and recycling facilities. I also saw some merit in exploring these messier and less 'glamorous' dimensions of an object's lifecycle, as these tend to receive less attention in the social sciences than do manufacture, marketing or design.

I began at home, in the kitchen. A rich, intriguing and 'stretchy' space (Buttimer 1980; Massey 1992), my understandings of constructions of home and domesticity and the histories of the kitchen were shaped heavily by Hayden (1985), Cieraad (1999 & 2002), Llewellyn (2002 & 2004), Henderson (1996), Freeman (2004) and Blunt & Dowling (2006). The politics of home are complicated. It is a place with which many people, particularly women, have an ambivalent relationship (Young 1997; Bowlby, Gregory & McKie 1997; Gurney 1997; Pratt 1999), for the 'ideal' of home as a site of ontological security, leisure and self-expression can coexist with an experience of it being oppressive, 'unhomely' or dangerous (Dupuis & Thorns 1998; Rybczynski 1986; Chapman & Hockey 1999; hooks 1990; Martin & Mohanty 1986; Honig 1994). Home is also a place of work. Although British kitchens are less the female preserve than they once were, the burden of labour is borne disproportionately by women (Oakley 1975; Strasser 1982; DeVault 1991; VanEvery 1997). Even where men and children are active participants in shopping, cooking, cleaning and organising, overall responsibility for domestic order still falls principally to women (Munro & Madigan, 1999; Kaufman 1998). Martens and Scott (2004, p. 36) observe that "female respondents use the 'I' word, implying that whilst they may not necessarily be the only ones to do kitchen tasks, they speak according to a cultural understanding that they are ultimately responsible for it." Part of the reason is that, unlike men, women often locate their gender identity in household labour above paid work, making caring work crucial to the ideological construction of femininity (DeVault, 1991; Silva 1999).

Domestic spaces, traditionally gendered feminine, are increasingly filled with or, as Terry and Calvert (1997) would say, 'saturated' with technologies (Cowan 1985b; Giedeon 1948; Silverstone & Hirsch 1992). Gender and technology are relational categories co-produced through making and using technologies (Wajcman 1991; Cockburn & Ormrod 1993; Cockburn & Fürst Dilić 1994; Fürst 1997; Lohan 2000; Silva 2000). De Lauretis (1987) theorises gender as a technology that produces and simultaneously naturalises difference, ordering relations into hierarchically unequal categories. As a 'grammatical' distinction between categories, gendering occurs to objects, spaces and ideas as much as to women and men (Franklin, Lury & Stacey 2000, p. 1, cited in Jacobs & Nash, 2003, pp. 268–269). It was to the objects and technologies in people's homes that I felt especially drawn and, therefore, to studies looking at the changing roles and values of things as they are appropriated into daily life (Silverstone 1994; Lally 2002). The material culture of home is a dimension of material culture studies whose profile has been raised in recent years, for example by Daniel Miller and the contributors to two edited collections (Miller 1998 and 2001; see also Attfield 2000, Pink 2004), as well as by the launch of the journal *Home Cultures*. My interests in engaging with, analysing and following material things led me to a growing literature on 'things' and to the work of Appadurai (1986) on the 'social lives' of things, Kopytoff (1986) on the 'biographies' of things, Csikszentmihalyi and Rochberg-Halton (1981) on the meanings of things, Jackson (1999) on the traffic in things, Cook (2004) on following things, Kingery (1996) on learning from things, Attfield (2000) on 'wild' things, Straw (1999) on the "thingishness" of things and Brown (2001) on 'thing theory.' In many respects, my research keeps returning to questions about how we use, accommodate, domesticate and live with things. Daily life can be regarded as a kind of dance, at once facilitated and constrained by a scaffolding of material objects. These are things-in-motion, hence I frame my study around a variety of journeys, ranging from transatlantic shipments to more modest manoeuvring of foods and kitchenwares.

Analyses of objects and commodities frequently focus more upon their meanings, or upon moments of acquisition or appropriation, and less upon their ongoing use or, still less, their divestment. While domestication is certainly a critical dimension of my discussion (Lie & Sorensen 1996; Cockburn & Fürst-Dilić 1994; Pantzar 1997), I do not want to overlook the later stages of objects' lifecycles as they are used, reused, repaired, recycled and destroyed. Just as Oakley (2002, p. 100-1) notes "the 'compulsory' nature of housework … [and] the unremitting obligation to do it or see that it gets done," so Graham and Thrift (2007) analyse the "remorseless and necessary," work of maintenance and repair more broadly. Material infrastructures are never fixed and stable entities but are subject to continuous interventions to maintain and mend them. Repair work is a major economic activity, the "engine room of modern economies and societies" even (Graham & Thrift 2007, p.19). Nevertheless, it tends to remain hidden and gets overlooked in most social analyses (some notable exceptions being Downey's (1998) and Orr's (1996) ethnographies of engineers and repair technicians), hence these scholars' motivation to "surface the invisible work" (Star 1999, p. 385). Graham and Thrift see these activities as integral to the Heideggerian notion of the world being 'ready-to-hand,' for "they are the main means by which the constant decay of the world is held off"; they are what constantly remake the world and keep it 'ready' (Graham & Thrift 2007, p. 1). What tends to remains invisible too "is that most consumption, and particularly routine everyday consumption … is also about replacing things, about getting rid of other things, about casting them out and abandoning them" (Gregson 2006, p. 6; see also Douglas 1966; O'Brien 1999; Marcoux 2001; Lucas 2002; Hawkins and Muecke 2003; Hetherington 2004). As part of this study, I ask how to fix a fridge that does not work and follow fridges that are thrown away to see the journey that they take through cycles of repair, into the waste stream, onto the scrap heap and beyond. In doing so, my ideas are informed by Thompson's fascinating analysis of the mobility of objects into – but also out of – the category of 'waste' in *Rubbish Theory* (1979), Strasser's social history of trash (2000), Gregson's work on 'ridding' (2006) and accounts by DeSilvey (2006) and Edensor (2005) of objects, buildings and landscapes subject to the process of decay.

My research is partly motivated by Latour's admonishment not to overlook the 'missing masses,' those 'humble' nonhuman actant-artifacts with which we co-produce our social world (1992). It also shares with the creators of *The Journal of Mundane Behavior* (Schaffer 2000) an impulse to attend to the 'unmarked,' the quotidian, the banal and everyday. To Latour's mind, knowledge is not a property of humans but of "humans *accompanied* by their retinue of delegated characters. Since each of those delegates ties together a part of our social world, it means that studying social relations without the nonhumans is impossible" (Johnson aka Latour 1988, p. 310). For insights into the use of objects in the daily 'doings' of domestic life, I looked to analyses of practice. Schatzki *et al* (2001) comment on a turn to practice, which is, in many ways, also a turn to everyday life. In their investigation of living and cooking in *The Practice of Everyday Life* (1994), de Certeau, Giard and Mayol focus not just upon 'operations' but also upon their 'sequences' and 'phrasing.' Bourdieu sees practice as "inseparable from temporality" (Bourdieu 1989, p. 81-2) but, given that action is always situated, arguably practices must also be inseparable from spatiality; indeed, de Certeau *et al* describe practices as "spatial stories" (1994, p. xxxii). They conceptualise these 'ways of operating,' as creative, opportunistic and 'tactical' in nature. Practice is also central to Giddens' theory of structuration for it proposes that at the heart of the social sciences "is neither the experience of the individual actor, nor the existence of any form of social totality, but social practices ordered across space and time" (Giddens 1984, p. 2). In turning to theories that treat practices as the 'smallest unit' of social analysis, Reckwitz (2002) observes that other kinds of cultural theory pay scant attention to implicit, tacit and unconscious levels of knowledge. He explains:

> A practice (*Praktik*) is a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge. … The single individual – as a bodily and mental agent – then acts as the 'carrier' (*Träger*) of a practice … Thus, she or he is not only a carrier of patterns of bodily behaviour, but also of certain routinized ways of understanding, knowing how and desiring. … The practice as a 'nexus of doings and sayings' (Schatzki) … is thus a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood (Reckwitz 2002, p. 249-50).

Crucially, therefore, practice involves routinised bodily activities *and* mental activities, as well as the use of objects in certain ways.

Knowledge comes in many shapes and sizes. Polyani (1967, p. 4) observes that "we can know more than we can tell" and draws out key distinctions between 'codified' (or what he termed ‘explicit’)[12] and ‘tacit’ knowledges. Codified knowledges are typically formal and abstract, associated with practices of enumeration, calculation and regulation, and with institutions like ‘the state’ or ‘science.’ Tacit knowledges, in contrast, are not readily captured in linguistic form, nor easily conveyed in written symbols on the page. Associated with ‘know-how’ and more easily known through doing than through telling, they appear to lack a framework of reason and abstraction and, as a consequence, risk being discounted as something other than ‘knowledge.’ If pressed, most people would acknowledge that there are multiple ways to ‘know’ the world, but, like putting on well-worn conceptual slippers, it is easy to slip comfortably into what Foucault would term a cognitive discourse of knowledge. It is not that we are all trapped unwillingly within this discourse or left “unable to think outside of its parameters; rather it is just easier to think *with* such a discourse than *about* it,” to inhabit it, rather than reflect upon it (Allen 2000, p. 18). Other modes of knowledge get overshadowed by its apparent ‘obviousness’ and our expectations about what we think knowledge should look like shapes where we expect to find it. We do not, for instance, routinely see the home as a site of innovation or knowledge-making, or, for that matter, the refrigerator.

In this study, I am interested in things like scientific papers, instruction manuals, patents and explanatory diagrams, but also in more embodied and habitual knowledges and practices picked up through repetition or learned ‘at Mother’s knee.’ But even as we try to separate them, categories of knowledge stubbornly tangle. Laboratory ethnographies have carefully drawn out the ways that both codified and tacit knowledges underlie the making of science (Lynch 1985; Latour & Woolgar 1986; Traweek 1988). In formal learning environments, much may be picked up informally, for scientists, physicians and the like learn from watching and intuiting too, even if they are positioned at what we might regard as ‘Supervisor’s Shoulder’ rather than Mother’s knee. People are consummate ‘bricoleurs,’ readily piecing together different kinds of knowledge in their daily lives. Scholars such as

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12 I prefer the terminology ‘codified’ and ‘tacit’ knowledge, and take these to be broadly equivalent to Thrift’s (1985) ‘empirical’ and ‘practical’ knowledges and Power’s (2000) ‘book knowledge’ and ‘body knowledge.’ I remain hesitant about just how explicit we can assume ‘explicit’ knowledges to be, or for whom, and wary that the term implies these knowledges spring forth pre-formed in some kind of inherently clear form; that knowledge is ‘codified,’ on the other hand, hints that it has actively been rendered into a certain form.

Keller (1985) and Haraway (1988) have demonstrated the gendered, classed, raced and otherwise 'situated' nature of knowledge and, as Barnes (2003) demonstrates in his analysis of histories of economic geographies, even abstract theoretical knowledges can be profoundly shaped by the spatial and temporal contexts in which they were produced. In terms of how knowledges then circulate, they rely upon a range of intermediaries, both human and nonhuman. Common understanding is that tacit knowledges do not travel well because of their reliance upon co-presence and mutual interaction. Tacit knowledges can be thought of as residing in a distributed sense within the body (Power 2000). As somewhat fleshy, many-tendrilled things, they can be difficult to gather up neatly and relocate, for such knowledge gets disrupted in the absence of contextual cues. Codified knowledges, meanwhile, are easier to unbuckle from one location and move elsewhere, as in the case of written texts, which make learning-at-a-distance possible. However, coding and decoding can themselves be heavily contextual, meaning that codified knowledge does not always arrive unmarked by its journey. As every good flight attendant reminds us when opening the overhead luggage compartments, we must take care because the contents are liable to have shifted while in transit. Our mobiles are not always as immutable as they appear (de Laet 2000), hence Allen, among others, refers to the 'translation' of knowledge, rather than its 'transmission' (2000, p. 27-8).

Secord describes the history of knowledge as being, in many ways, a history of circulating practices (2004). He considers the turn to studying practice, and to approaching knowledge as a form of practice, to be one of the more significant transition in recent decades because, "most fundamentally, it broke down the distinctions between words and things, between texts, books, instruments and images" (2004, p.658). This leads me to Pantzar and Shove's 'choreographies of practice' and their attempts, in recent years, to produce an integrative theory of practice. They see 'materials,' 'images' and 'skills' as the three main components from which practices are composed and argue that the 'careers' of practices, that is, the ways in which practices come into being, persist or disappear, depend upon relationship between these three ingredients. Shove (2002) emphasises that practices do not neatly 'stabilise' so much as continue to de- or re-stabilise. She analyses how novel systems of practice become normal, arguing that the notion of 'normality,' and the way it varies over time and among different social groups, is critical to understanding practice. Although practices can become fairly established and customary procedures can be adhered to unreflexively, practices remain dynamic nonetheless. Conventions get contested and practitioners are liable to improvise and experiment, meaning that practices always contain within themselves the possibility for change and innovation (Warde 2005). Amongst a range of alternative cooling and preservation methods, mechanical refrigeration emerged as a new practice and, whilst formerly widespread practices like home-bottling have declined, the refrigerator won sufficient adherents for its 'career' to build momentum and see it become an integral part of most British homes.

White box, black box

The refrigerator has stabilised as one of a suite of 'normal' kitchen appliances, along with things like washing machines, cookers and, more recently, microwave ovens. All fall under the designation of 'white goods,' irrespective of whether they are actually diamond white, harvest gold, stainless steel or bubblegum pink. In contrast to other kitchen appliances, from which things emerge variously cleaned, baked, toasted, blended or otherwise transformed, the fridge is unusual in that its job is keeping things the same. Early on in my research I became aware of a common perception that a fridge does not really seem to *do* much. It is frequently regarded (at least in the case of those fridges not yet reborn with the ability to make music, check email or orchestrate the actions of other household appliances) as little more than a glorified cupboard. Interviewees commented that, after all, a fridge does not take much skill to use, so long as one has the basic dexterity to open the door and move things in and out. Rarely needing even to be switched on or off, it makes few demands upon its users' attention but just sits there keeping cold and sometimes humming to itself.

The raison d'être of the refrigerator is to hold foods in a cold embrace so as to slow their journey into degradation and decay. As such, it generates interesting tensions between processes of 'preservation' and 'transformation.' I became intrigued by the contradictions between its apparent passivity, its static nature, it role of simply holding things, and the work that goes on within it hidden out of sight and I go on in Chapter 2 to investigate the nature of this work and show how the operation of a refrigerator is much more dynamic, and its effects much more far-reaching, than its outward appearance might suggest. Creating cold is a complex and ongoing achievement. The refrigeration mechanism runs twenty-four hours a day, making continual adjustments to maintain a consistent temperature. And it seems that even holding might not be as straightforward as it looks.

As my research involved many different kinds of containers – from refrigerators and ice boxes to archive boxes, cargo holds, museums, pistons, pipes and tubes, houses, trucks and shopping bags – I read Zoë Sofia's work on 'container technologies' (2000) with considerable interest. She directs attention to the habit of conceptualising containers as passive and feminised receptacles. "We take for granted containers and the resources they supply; they are merely spaces to get stuff out of or put stuff into" (Sofia 2000, p. 185). Mumford argues for the importance of those devices and utensils that perform roles of holding, protecting and preserving:

> Cooking, milking, dyeing, tanning, brewing, gardening are, historically, female occupations: all derive from handling the vital processes of fertilization, growth, and decay, or the life-arresting processes of sterilization and preservation. All these functions … are inconceivable without baskets, pots, bins, vats [and] barns. … We tend to devaluate all these stabilising processes: even our containers, from the drinking cup to the recorder tape, are meant to be as transitory as the materials they contain (1966, p. 140-1).

Usually unobtrusive and often associated with women's work, such objects rarely feature in our histories of technology, prompting Sofia to set about recasting 'containing' as an active process. She draws upon Heidegger's writings on 'holding' and 'supply.' In his essay on 'The Thing,' Heidegger talks about a jug and how "the emptiness, the void, is what does the vessel's holding" (1971, p. 169). The making of a jug is therefore less about the shaping of materials than it is about the fashioning of a space. The refrigerator performs a twofold task of holding. It is a box of sorts and as such performs the work of containing those things placed within its interior. By its action of cooling, it also endeavours to hold them in a state of arrested decay. Both are active rather than passive states of holding.

My interviewees were familiar with the cabinet's 'void' and how it could be used, but, when I asked, most had little inkling about how the cooling mechanism worked. Few felt the need to know *how* a refrigerator worked, what mattered was that it did. The refrigeration unit was taken to be a rather mysterious device that managed to keep things cold, almost as if by 'magic.' It had been 'black boxed.' As Latour explains in *Pandora's Box*, "the word black box is used by cyberneticians whenever a piece of machinery or a set of commands is too complex. In its place they draw a little box about which they need to know nothing but its input and output" (1999, p. 2-3). Understanding the principles of refrigeration may be helpful, but it is not a prerequisite for putting things in the fridge or taking them out again. Thrift points out that along with knowing come various forms of 'unknowing,' which affect the knowledges available to be thought with. He identifies five kinds (1985, p. 369-71). Knowledge may be 'unknown,' meaning it is not present or accessible and therefore impossible for people to have in a given space or time. An example would be the notion of 'germs' prior to germ theory, which I discuss in Chapter 4. Alternatively, knowledge might be available but not understood because it falls beyond one's experience or frame of reference. Ideas may be too complex for someone to grasp without training in a specific field, or might represent too much of a disjuncture from one's current system of belief to be comprehensible. Unknowing also arises if knowledges are deliberately hidden or distorted, or if taken-for-granted knowledges remain undiscussed, which helps conceal the nature of their construction.

For Latour, "buying a machine without question or believing a fact without question has the same consequences: it strengthens the case of whatever is bought or believed, it makes it more of a black box" (Latour 1999, p. 29). A number of interviewees confessed their lack of knowledge guiltily, believing it was something that they really ought to know. Some even felt the need to promise me they would go away and learn, despite my assurances that it did not bother me remotely whether they knew or not. It was clear that knowing how to use something and knowing how it works can be quite different things. I wanted to know both.

Latour's approach to studying science is to get there before the box closes to see "facts and machines while they are in the making" and watch how black boxes get made and closed and strengthened (1999, p. 13-15). When sufficient weight is mobilised in their support, 'facts' are created and the social and geographical specificity of their creation gets erased. It becomes easy to forget that there was a period of uncertainty or contestation before the matter was settled, for "the original discovery … [gets] incorporated into tacit knowledge with no mark of its having been produced by anyone" (1999, p. 43). Part of my aim in this dissertation is to open up the black box drawn around this white box to gain a better understanding of not just what goes into and what comes out of a refrigerator, but also what goes on inside. I am interested in the combinations of materials, knowledges, efforts and beliefs from which the fridge is built, as well as the acts of closure that made it the shape it is. Maintaining closure is, as Hand & Shove (2007) point out, an ongoing process. I visit the refrigerator 'in the making' and follow it into the home to see the roles it played in daily lives and practices. But more than that, I want try to produce an account capable of combining a diverse range of objects, ideas, registers and scales. Mitchell talks of techno-politics as "an alloy that must emerge from a process of manufacture whose ingredients are both human and nonhuman, both intentional and not, and in which the intentional or the human is always somewhat overrun by the unintended" (Mitchell 2002, p. 42-3). While he brings analyses of war, famine, epidemics, dams and fertilizers together in an account that is at once "hydraulic, chemical, military, political, etiological, and mechanical" (2002, p. 27), my interest is in elucidating relationships between refrigerators, knowledges and practices by creating explanatory stories out of milk bottles, microbes, fridge magnets and Freon, Antarctic expeditions and supermarket shopping, germs and ice, beef and electricity, international diplomacy, limp lettuce and chilled dainties.

FRIDGE TALK, TEXTS AND TEA

My research roamed through many places and could perhaps be regarded as a mobile 'multi-scaled' and 'multi-sited ethnography' (Jacobs 2006; Marcus 1995; Hannerz 2003). The earlier and more historical section of my dissertation makes use of archival material, the middle section is more heavily interview based and the end draws upon a mixture of policy analysis and participant observation. I carried out 32 interviews in the course of this research. Eleven were what could be categorised as 'workplace' interviews, on the basis that I contacted the individuals in question because of their involvement with refrigerators in a professional capacity. The other 21 were 'household' interviews, where I set out to learn more about people's domestic practices and refrigerator use and how these had changed over the course of their lives. The majority of my interviews took place in people's homes, the result being that I sat in many kitchens and I drank a lot of tea, much like Daniel Miller who, reflecting on his experience of doing ethnographic research in Britain, commented that "it would be difficult to research domestic consumption … if you weren't fond of tea" (Miller 1997, p. 14). I could not help but smile as it dawned on me how swiftly Britain's rituals of hospitality lead to an open fridge; I was routinely offered tea or coffee as soon as I arrived in someone's home, along with milk fetched from the fridge.

One unexpected difficulty I have is defining where the 'workplace' interviews end and 'household' interviews begin. There is a lot of fraying at the edges of these categories, not least because, for many people 'home' is simultaneously a place of work. In addition, two of my 'household' interviews took place outside the home. I arranged to interview Tony Hawks in a café, ostensibly to discuss his book (1998), but because we talked at length about his domestic arrangements and the ways in which he negotiated the refrigerator as a space shared with two lodgers, I have included this as a 'household' interview. On the other hand, although I did interview Tim Hunkin in his home, I regard this as a 'workplace' interview because our discussion concentrated on the technology of refrigeration, the domestic appliance gallery he designed for the Science Museum and the television series called *The Secret Life of Machines* that he made in the late 1980s and early 1990s.[13] In addition, during my discussions with people in a work context, many shared their own refrigerator stories – childhood memories of first getting a refrigerator, recollections of their parents' and grandparents' kitchens or accounts of how their shopping and eating habits have changed – illustrating how hard it can be to neatly cordon off domestic spaces or practices from other spheres of people's lives.

Access to my first interviewees came via the Science Museum in London, through which I was able to make contact with individuals who had donated or offered refrigerators to the museum's domestic technology collection in the past few years. It did not prove possible to

13 The Secret Life of Machines was shown in Britain on Channel 4, and subsequently on the Discovery Channel. Each programme investigated a particular machine and The Refrigerator was one of the six covered in the first series, broadcast in 1988. A second series aired in 1991 and a third in 1993. The programmes can be viewed online at http://www.exploratorium.edu/ronh/SLOM/.

trace early donors, due to the time that had elapsed, but I was able to interview the three most recent, all of whom were delighted that their refrigerators had aroused the interest of a researcher. The first was Dorothy Ladd, who had been hopeful that her 1959 Kelvinator would find a home in the collection. To her great disappointment, after visiting her home to view the refrigerator, the museum's Curator explained that, unfortunately, he would have to decline her offer because space constraints for storage of large objects meant that only the strongest cases for new acquisitions now received approval. I interviewed Dorothy the following week and she was the one interviewee I met with twice, for I visited her again the following summer to find out the fate of the fridge and to meet its replacement. Next, I talked with Fred and Marianne Emery about their large American 1960s Whirlpool fridge (discussed in detail in Chapter 6), which they donated to the museum in 2000, and then with Ruth Hägen, whose eye-catching bright red 1952 Electrolux was in transit to the museum's store at the time we spoke.

My interviews were not intended to be a 'representative' sample. I was interested in talking to people from diverse social, cultural and economic backgrounds, but I made the decision early on in the project to focus in particular on people with 'pre-fridge' memories who would be able to reflect upon the changes in household technologies and domestic practices within their lifetimes. As such, my interviewees are quite deliberately skewed towards an older age range. Participants ranged in age from their late 20s to their mid 80s but two thirds were 50 years or older and half were over 60. I set about actively recruiting older participants in two main ways. First, I contacted an organisation called Age Exchange, which runs a 'Reminiscence Centre' in Blackheath, in southeast London (http://www.age-exchange.org.uk/centre/).[14] There, I was able to do a joint interview with Gwen Wiseman

14 Age Exchange was founded in 1983 and the Reminiscence Centre in Blackheath opened four years later. It operates as a resource centre, the headquarters for British and European Reminiscence networks, a museum of early-mid 20th century daily life, a gallery with changing exhibitions, a community centre with a busy social, cultural and educational programme and the base for a professional theatre company called 'The Memory Makers.' Promoting the therapeutic value of reminiscence work, the Centre aims to reduce social isolation by bringing older people together in reminiscence-based creative activities and to enhance their quality of life of by valuing their memories and life stories. One important facet of the Centre's role is its work with dementia patients. Because those with dementia are often able to access their long-term memories, Age Exchange offers training in reminiscence skills for professionals, carers and family members as a way to

and Iris O'Neill, two volunteers at the Centre. My early interviewees were based mostly in the London area so I wanted to complement these with interviews carried out elsewhere. I approached the editor of a parish newsletter in a village in Norfolk, in the east of England, whom I knew to be active in gathering local history. I anticipated that he might know of older people locally who would be willing to participate. He was able to recruit three sets of interviewees on my behalf from a rural area and a nearby town: Geoff and Nancy Bauer, Jonathan and Doreen Knight and Ronnie Porter. I then approached Betty Wood, who had lived her entire life not far from the place where I grew up. Her husband had worked as a farm hand and she had worked as a cleaner for a local farmer and I was interested in interviewing her because I knew that the couple had lived for many years in a virtually unmodernised farm cottage.

Recruiting my other interviewees was partly strategic and partly opportunistic. I made use of a range of social networks, my own and other people's. For instance, as well as interviewing Lisa Cooper, I arranged to interview the Ghanaian family who lived in the flat above. On another occasion, I was staying with a friend in London because she lived conveniently close to the National Archives. Her husband is in the armed forces and they live in housing provided by the Ministry of Defence. On hearing more about my project, she promptly took me to visit a family friend, Abigail Rowles, who has a highly unusual corner larder fridge. She also introduced me to her new neighbours, the Bashirs, a couple in the Pakistani Air Force living in Britain temporarily for a year and renting all their household goods, including their refrigerator. Someone else suggested interviewing Maggie and Simon Marsh because she worked full-time and he stayed home as a 'househusband' (though, unfortunately, he was unable to participate in the interview at the time I visited). While I did approach some interviewees because their domestic situation or their connections with refrigerators was unusual in some way, I talked to most people precisely because there was nothing outwardly remarkable about their homes or habits or their refrigerator use.

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enhance communication. Material culture plays a central role in stimulating peoples' memories and the Centre contains displays of familiar household objects, books and clothing, wartime memorabilia and a reconstruction of a 1930s shop. These objects also act as a social history resource to educate younger people about social and economic change and Age Exchange runs 'Living History' workshops with schools and colleges to enhance inter-generational understanding.

In addition to my conversations with fridge users, I thought it would be useful to speak to some people who did not have a fridge. Identifying such people proved to be the most challenging component of my research. I was not sure the best place to begin to track down the very small percentage of the British population without one so started in a rather ad hoc way by asking friends and colleagues if they knew of anyone without a fridge. I drew a blank. This was disappointing, but quite revealing in itself. I decided to switch tack and focus on approaching Health Visitors,[15] on the basis that they were members of a profession who would have first-hand knowledge of their clients' living arrangements. I contacted a few in the area of London where I was staying temporarily, which I knew to have a high number of refugee claimants, to see whether it might be possible to talk with a family newly arrived in Britain who were living without the kinds of household equipment most people took for granted. Unfortunately, the health visitors I approached were too weighed down with their own caseloads to help me, thought that language barriers would pose a problem or did perhaps not feel comfortable passing on my request. It was eventually through a health visitor that I found my first fridgeless family, though not in quite the way I had expected. I got in touch with one in rural Norfolk, imagining that she might know of some elderly farming couple still resolutely living without modern appliances. Instead, by happy accident, her son happened to be dating the daughter of a family who lived, by choice, without a fridge and who were more than happy to speak with me. My second fridge-free interviewee was with someone I had met through mutual friends some years before. I recalled that as a student he had lived in a 'bender,' a self-built dwelling in the woods with no electricity, so reasoned that was unlikely to have had a fridge during this time. When I contacted him to ask about this period, I was delighted to discover that that although he now had a young family and lived in a somewhat more conventional house, he still did not have a fridge. I therefore managed to interview two families without refrigerators, as well as Dorothy Ladd, who happened to have been 'between fridges' for a month or so at the time I visited.

15 A health visitor is a registered nurse who has received additional training in primary health care and community nursing. A major part of their role involves visiting people in their homes, such as new mothers or those suffering from chronic illness, and they often work closely with at-risk groups.

Most interviewees' initial response to my research was a mixture of surprise and amusement, close followed by curiosity. Few had previously given their fridge much thought and, even if they thought my topic a little peculiar, I was struck by the enthusiasm with which they engaged in 'fridge talk.' In much the same way that Gullestad noted that "when interviewing people about their house, one quickly discovers that talking about houses often involves telling a life story" (1997, p. 51), so I found that most interviewees seemed to thoroughly enjoy talking about their refrigerators because doing so meant talking about their lives, their childhood memories, their families, their daily routines, their favourite foods, their tastes and aspirations and, from time to time, their spouse's irritating habits.

Not all of my approaches were successful, however.[16] I had been excited to notice a small refrigeration repair business operating out of a house on the street adjacent to where I was staying in south London. It seemed ideal. I had it all planned – I would be able to spend time watching the work that went on in their workshop and could also be there with just a few minutes notice when they had call outs. I was very disappointed when I contacted the company and they turned down my request to carry out research with them. Eventually, I interviewed another electrical engineer, Mike McFadyen who did refrigerator repairs. My conversations with him provided insights critical to the direction this dissertation took and I learned a lot from him about the business of repair. My only regret was that although he told me fascinating stories about going to repair appliances in people's homes, the timing of his schedule and my research trips always ended up precluding me from accompanying him on any home visits.

My 21 household interviews (20 in person and one by telephone) involved 30 people (21 women and 9 men)[17] and represent a total of 22 households, because at the Blackheath Reminiscence Centre I interviewed two friends together. Eight of the interviews were with

16 During a spell of fieldwork in London, I could not help noticing that one house I passed by each day on the way to the station had a fridge-freezer standing outside the front door for some weeks. I dropped a letter through their door explaining my research and asking if I might talk to them about where this fridge was headed and about the new one I suspected had taken its place inside. I called back on a number of occasions to see if they would be willing to participate, but although I was convinced I saw the curtains twitch, no one answered the door. I took that as a no.

17 Although younger children were occasionally present, I did not formally include children in the interviews.

couples (7 heterosexual couples and 1 lesbian couple), 12 were with women (2 single, 5 widowed and 5 who participated without their partners) and 2 were with men (1 single and 1 widowed). In two cases, I spoke with women and their mothers: following my interview with Lisa, I then carried out a phone interview with her mother, Janet, who had expressed interest in participating in the project; when I visited Ruth Hägen, her mother, Mona, happened to be visiting from Canada and joined in for part of the conversation. The 22 households included 13 couples, 5 with dependent children, 7 single-person households, plus one single man and one single woman who each shared their homes with lodgers. Most of my interviewees were owner-occupiers but two lived in rented local authority housing, one rented from a private landlord and one lived in military housing. My interviewees included one black family, originally from Ghana, and one Asian couple, who had previously lived in Pakistan. The remainder were white and included one Swede and two Canadians. One of the women I interviewed was registered disabled and one of the men was suffering from a terminal illness. In my analysis, age and gender are the variables upon which I focus most attention, followed, to a lesser degree by class. I briefly touch upon some of the differences interviewees observed from having grown up in different countries and sociocultural contexts, but, although there are potentially interesting intersections between people's domestic practices and other axes of identity, such as sexuality or whether or not they are able-bodied, these lie beyond the scope of this particular study.

I carried out in-depth, semi-structured interviews, all recorded, with the exception of the one telephone interview. Where quotations in the text are not otherwise attributed, they are extracts from my own interviews. I introduce interviewees using full names but, on the basis that I generally refer to them by first name thereafter, I have listed interviewees alphabetically by first name in Appendix A for ease of reference. Most interviewees have been given pseudonyms; however, there are a few individuals I have not anonymised because they could be considered 'public figures' who have presented on television and published books under their own names. As this was part of my reason for interviewing them, I have not attempted to conceal their identities.

As well as conducting my own interviews, I also made use of the national collection of oral histories held in the British Library's Sound Archive. My principal source was the 'Millennium Memory Bank' (MMB), which contains recordings of interviews with 6,000 Britons of all backgrounds who, in the lead up to 2000, reflected on how life had changed during their lifetime (http://www.bl.uk/collections/sound-archive/millenni.html).[18] Interviews covered sixteen main themes and my interests lay in those portions concerned with 'house and home,' 'growing up,' 'eating and drinking' and 'technology.' A search of the interview summaries enabled me to identify those in which interviewees talked at length about changing practices of cooking, shopping and eating, new domestic technologies and, in a number of instances, refrigerators specifically. I also drew from one of the National Life Stories Collections (NLSC) called 'Food: From Source to Salespoint' (FFSS), which interviewed people working in food production, distribution and retail. I cite from 13 of these oral histories, using (MMB) and (FFSS) respectively to indicate where the material is held. I listened to the original recordings of about half of these interviews and worked from detailed transcripts of the remainder. Full details are provided in Appendix B. As in Appendix A, individuals are listed alphabetically by first name; however, because these oral history interviews are in the public domain, I do not use pseudonyms. Although there are certain challenges in making use of interviews conducted by other people, these are lessened somewhat in this instance by being able to listen to the original recordings. The MMB and NLSC represent a valuable resource because they give access to far more interview data than it would have been possible for me to gather alone. In addition, it was helpful in enabling me to supplement my interviews with a broader range of working class perspectives, for instance, from participants who had formerly been employed in domestic service.

In addition to Tim Hunkin and Mike McFadyen, mentioned above, my 'workplace' interviews included discussions with Andrew Ellis, the Curator of the Science Museum's domestic technology collection, Thomas Driver, the Head of Collections, and Jason Arlington, a member of the team responsible for overseeing the reserve collection held off

18 The Millennium Memory Bank is one of the largest oral history projects to have been conducted. In 1999, the British Library worked in collaboration with local BBC radio stations across England, Wales, Scotland and Northern Ireland to gather oral histories, with the intention of creating a 'sound map' of the century.

site in the Museum's Large Object Store. I spent a couple of months based in the Science Museum over the course of two summers, principally to do archive work, but I also had the opportunity to spend time informally with curatorial and gallery staff while I was there. I made a series of visits to Respond, a charitable organisation in southeast London that collects, refurbishes and sells unwanted furniture and appliances. My time here involved a combination of interviews and participant observation. As well as conducting interviews with Henry Drake and Shaun Carter, the Chair and Business Development Manager, I also spent a day out on the van with Rod and Jacko, one of the teams collecting donations, and another day in the workshop talking with Doug Mansley and watching him as he tested and repaired electrical appliances. I interviewed Ian Staunton, Waste Manager at Greenwich Council, and Carl Aspin, Operations Manager at EMR's fridge recycling plant in London, but the need to move around the site and the noise of the machinery precluded me from taping these conversations so I relied upon ethnographic fieldnotes (Emerson, Fretz and Shaw 1985). As well as interviewing Alan Cooper, a refrigeration engineer and author of *The World Below Zero: a history of refrigeration in the UK* (Cooper 1997), and Brian Williams, Technical Product Manager at LG Electronics, I visited a couple of trade shows and exhibitions – the Ideal Home Exhibition and 'Stuff! The Gadget Show,' both in Wembley, London – which gave me an opportunity to learn more about contemporary trends in appliances and kitchen design.

In terms of sources for archival material, I made use of the Science Museum Library and Archives, based next door at the University of London's Imperial College. Some of the refrigerator handbooks dating from the 1920s to the 1950s, which I discuss in Chapter 4, came from the Science Museum files relating to particular models in its collection; others were held in the British Library, the New York Public Library or the University Library at Cornell. The Wellcome Trust Library in London proved to be a good resource for materials on health, cooking and food safety and the Women's Library in East London held some useful material, on the Electrical Association for Women. I visited the History of Advertising Trust in Norfolk and, in Brighton, spent time in the Design Council Archive and the Mass-Observation Archive (MOA), housed at the University of Sussex (www.massobs.org.uk). The MOA contains the papers of the Mass-Observation social research organisation dating from the 1930s to the 1950s, as well as material about everyday life in Britain collected since the 1980s.

One of my most fortuitous finds came in the shape of Jenny Webb, a former Appliance Demonstrator and Home Economist who had spent her entire career in the electricity industry. I visited her at her home in London and interviewed her about her professional experience and her own domestic practices. As well as blurring divisions between 'household' and 'workplace' interviews, the discovery that her personal papers represented probably the most useful collection of materials that I came across in the course of my research also worked to disrupt distinctions between 'home' and 'archive.' She generously kept me fuelled with tea and snacks as I made a second visit the following day to work through as many of her papers as I could before I had to leave to catch my flight. Subsequently, I was able to spend time at the Museum of Science and Industry in Manchester, where I viewed the papers and photographs she had donated to the museum's Electricity Council archive a couple of years before.

A BRIEF ROUTE MAP THROUGH THE DISSERTATION

In chapter 2, I sketch out the trajectories of natural and artificial cooling practices. I look at the trade in natural ice, explore competing understandings of heat and cold, trace the means by which cold came to be 'created' artificially and consider how this contributed to the spatial reorganisation of Britain's perishable food supply. Chapter 3 follows the journey of mechanical refrigeration into the home. I examine the infrastructures supporting first domestic ice use and then artificial methods of cooling. I pay particular attention to the role of the electrical industry in shaping the norms of domestic refrigeration in contemporary Britain and in mobilising women as 'vectors' of modernity. Chapter 4 focuses on refrigerator knowledges, the various ways in which those knowledges circulate, the new forms of knowledge that emerged with the adoption of refrigeration, as well as old forms that were displaced. Here, I argue that refrigerator use is not self-evident but relies upon a set of knowledges and practices that are learned. Chapter 5 examines practice in more detail and assesses ways that shopping, provisioning, cooking and eating were reconfigured with the adoption of refrigeration. I explore ways in which the refrigerator is negotiated as a social space and gets appropriated in ways unconnected with its function of preserving food. I show that the refrigerator has been 'normalised' as an integral component of the kitchen to such a degree that although its introduction is relatively recent, few contemporary Britons would contemplate the idea of living without a fridge. Chapter 6 asks what happens when fridges fail. I consider practices of repairing and reusing refrigerators and follow them as they pass through the waste stream to see how they are disposed of. This chapter focuses in particular upon a national crisis in fridge disposal that emerged in 2002. I explore what happened when domestic refrigerators, usually thought of as 'small' and largely invisible appliances, strayed 'out of place' and got caught up in much 'bigger stories' (Jacobs 2006).

Chapter 2

Catching Cold: Histories of Natural and Artificial Cooling

THE CONFECTIONERS' PRECARIOUS COMMODITY

In the third week of January 1822, a cold snap descended on Britain, which was warmly welcomed by the country's confectioners. Had temperatures not dropped below 0°C long enough to form ice, the summer's ice cream supplies would have been in jeopardy unless they resorted once more to the innovative but risky undertaking reported in *The Times*:

> The confectioners have been able to lay in a store of ice to freeze their creams in summer! If the frost had not favoured them last week, they might have been obliged to send, as heretofore, to the coast of Greenland for a cargo; but their last venture of that kind, six years ago, was, like every speculation in a slippery commodity, attended with such risk that it has made them averse from repeating the experiment (*The Times* 1822, p. 3).

Allegedly cleaved from an iceberg, harnessed in some fashion to a ship and towed to London, the article goes on to note that "the remnants of the precarious commodity were, in haste, distributed among the ice-houses in town." As well as indicating that there were ice houses around London in which ice was stored until summer, and suggesting that the market for ice cream in 1816 was sizeable enough to warrant such an endeavour, this article is perhaps the earliest record of ice having been 'imported' into Britain. Most histories of the ice trade cite 1922 as the year in which ice was first imported but, although not strictly a formal trade between nations, arguably this 1816 venture represented the start of Britain procuring ice from beyond its own shores. Despite the freezing temperatures that eventually arrived in the January of 1822, this was the year that marked the start of a century-long ice trade with Norway. It seems that imports were initiated by English merchant William Leftwich, though trade got off to a somewhat faltering start (Fussell 1956, p.131). Blain's Norwegian sources indicate that, much to Leftwich's dismay, having set sail from Norway with a cargo of ice, by the time it reached London the ship was close to sinking and its contents almost all melted (Blain 2006, p. 1). Cooper reports a more successful landing of

Norwegian ice in London later that summer and, within a few years, ice had become a familiar cargo (1997, p. 2).

In a letter written to a friend in 1828, Richard Trevithick (1771-1833), a British engineer who developed the high pressure steam engine, alluded to the growth in the ice trade in the intervening six years:

> A few days since I was in company where a person said that one hundred thousand per year was paid for ice, the greatest part of which was brought by ships for that express purpose from the Greenland seas (Trevithick 1828, cited in Cooper 1997, p. 20).[19]

His letter is particularly interesting because the next line goes on to envision that steam engines could be employed to power artificial refrigeration devices and so provide a way of creating cold mechanically without the need for ice:

> A thought struck me at that moment that artificial cold might be made very cheap by the power of steam engines, by compressing air in a condenser surrounded by water, and also an injection into the same so as to instantly cool down the very highly compressed air to the temperature of the surrounding air and then admitting it to escape into the liquid to be cooled. This would reduce the temperature to any rate of cold required.

Although the idea was not one he would pursue himself, Trevithick neatly captures here the principles upon which mechanical refrigeration was based, a method which would, as he predicted, eventually produce cold more cheaply and efficiently than physically transporting blocks of ice around the world.

My purpose in this chapter is to unravel the story of this transition from harvesting and using natural ice for cooling, to making ice artificially and then to producing cold mechanically and, in doing so, to demonstrate how the refrigerator acted as a technology collapsing time and space. In the following chapter, I go on to explore how this method of making cold by machine moved into the home. Although my focus is on Britain, tracing the development of mechanical refrigeration necessarily leads us on a journey to Norway, the United States, India, Germany, France, South America, Australia and New Zealand and through periods

19 The letter was written to Davies Giddy (later Gilbert), a fellow engineer and President of the Royal Society from 1827 to 1830.

from the seventeenth century to the present day. After exploring the complexities of moving ice, and the great lengths to which people went to acquire frozen water, I then go on to consider the complexities of moving heat, for it is the ability to manipulate its movement through a system that lies at the heart of refrigeration.

I trace the evolution of competing theories about heat and cold and note the knowledges that had to be in place for certain innovations to occur. I am interested in developments by different people in different times and places, as well as the conversations, literal and figurative, and the exchanges of ideas that took place between them. I 'walk through' an exhibit in the Science Museum in London as a way to meet the innovators and explore the key developments upon which histories of refrigeration have been built. My stories are about journeys, about the interplay between movements of molecules and of ideas, of ice and ships and meat, of gases passing through tubes and valves and of what people bought to eat. I show how the desire to cool beer and meat became principle driving forces behind early applications of refrigeration and emphasise how developments in this technology vastly extended the longevity and reach of perishable foods.

In this chapter, I touch upon various forms of 'catching' cold, whether that be grappling with icebergs or cutting ice from ponds; adopting certain practices or modes of thought as they caught on, from a fashion for using ice in drinks to a particular theory of heat; grasping the physics of cooling; attempting to control the movement of heat within a machine; or trapping cold air inside an insulated icehouse or refrigerator. I argue that the ability to make cold mechanically represents a highly significant technical achievement and one that demonstrates the intimate interconnectivity between scales, from the microscale at which molecules move to the global transportation of foods.

HARVESTING AND TRADING NATURAL ICE

Bacon, chicken and snow

Historically, there are records of snow being collected, stored and sometimes moved great distances. Wealthy Romans, for instance, could acquire snow transported from the Apennines and in the early Middle Ages snow was conveyed by camel from Lebanon to supply the palaces of Damascus, Cairo and Baghdad (Thévenot 1979, p. 23). In Britain, the earliest reference to testing snow's preservation properties seems to be of an experiment performed by Francis Bacon (1561-1626). In the later years of his life, Bacon, a philosopher and one-time Lord Chancellor to King James I, had turned to interests in natural philosophy and science. Curious as to whether snow would keep meat fresh as an alternative to salting, Bacon put his theory to the test one snowy day in London in March 1626. Thomas Hobbes, one of Bacon's associates, recounted the story to John Aubrey, who retells it in his collection of *Brief Lives*:

> As he was taking the aire in a coach with Dr Witherborne (a Scotchman, Physitian to the King) towards High-gate, snow lay on the ground, and it came into my Lord's thoughts, why flesh might not be preserved in snow, as in Salt. They were resolved they would try the Experiment presently. They alighted out of the Coach and went into a poore woman's house at the bottom of Highgate hill and bought a hen, and made the woman exenterate it, and then stuffed the body with Snow, and my Lord did help to doe it himselfe (Aubrey 1949, p. 16, spelling as in original).

Unfortunately, Bacon did not survive to investigate refrigeration further. He fell ill suddenly and was taken to the home of the Earl of Arundel, where he died a few days later from pneumonia, allegedly developed from a chill he caught that day in the snow. Affectionately christened by Cooper as "an early and distinguished martyr to the cause of refrigeration," Bacon wrote a letter to Arundel on 9th April 1626, the day he died, in which he explained:

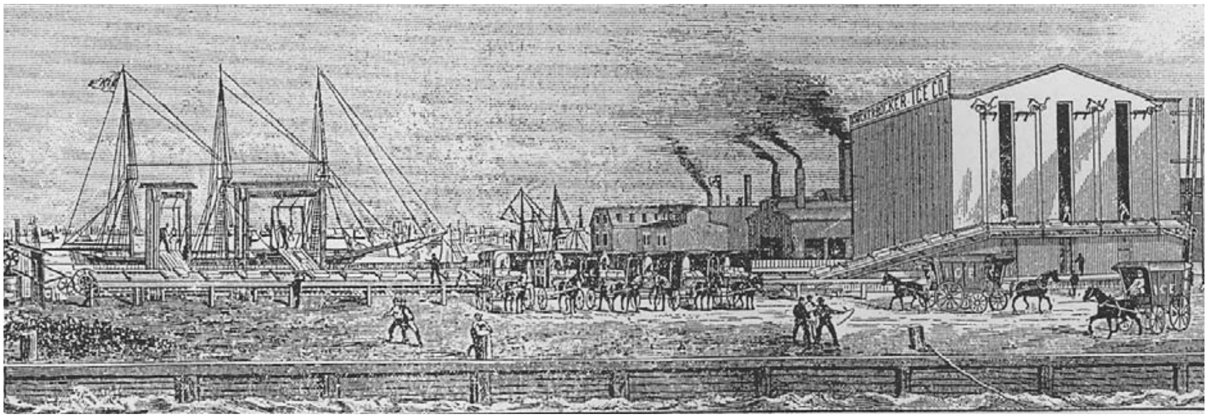
> I was desirous to try an experiment or two touching the conservation and induration of bodies; as for the experiment it succeeded excellently well (cited in Cooper 1997, p. 1).

Unroofing the house of fishes

Although few early records exist detailing the practice of harvesting or using ice in Europe or North America, it is likely that in winter ice would have been removed from ponds and rivers on a small scale using basic tools (Figure 2.1). It is difficult to gauge the extent of such use historically, for ice use does not mark the landscape in the same way as fire leaves traces of its presence that archaeologists and historians can 'read'; as it melts and disappears, ice leaves little record, save for the ice houses, or the remnants of such structures, which offer some clues, usually about ice use among the wealthy (Crawhall & Lentaigne 1934, p. 6). What we do know is that in the early nineteenth century, a highly organised and mechanised natural ice industry developed in the United States and grew to a scale now difficult to comprehend (Figure 2.2).

Figure 2.1 Small-scale ice harvesting, mid-nineteenth century, *The London Illustrated News*, 5th January 1850

Figure 2.2 The Knickerbocker Ice Company. Ice can be seen being unloaded from ships, carried on a mechanised conveyer belt, stacked in an ice store and delivered by a fleet of horses and carts.



Source: Hall (1888) *The Ice Industry of the United States*, p. 19

In his reminiscences about Walden Pond near Boston, Thoreau writes evocatively about the ice cutting he witnessed while visiting in the winter of 1847. He paints a picture of the large commercial teams at work, cutting ice for export, and also the small scale individual use that would formerly have been the norm. Just as our confectioners used ice that had been harvested the previous winter and safely stored in icehouses into the summer, or at least they did so when the climate cooperated, so Thoreau describes the figure of the landlord coming from the village in winter to collect ice to cool his drinks in summer:

> he cuts and saws the solid pond, unroofs the house of fishes, and carts off their very element … to wintry cellars, to underlie the summer there (Thoreau 1954, p. 54).

In eighteenth-century Britain, ice was harvested from ponds, lakes and inland waterways, such as the Regent's Canal in London and the Norfolk Broads (Furnival 1998, p. 57). There are descriptions in *The London Journal* in the early 1770s of cart-loads of ice being taken from the canal in St James's Park to an icehouse newly built in Green Park to store ice for the Royal household (Cooper 1997, p.1, citing *The London Journal* January 1774 and November 1773). It is hard to know when a domestic trade in ice began. Few accounts survive of what would originally have been a small and rather ad hoc trade, though Hardyment finds evidence dating from 1726 when "eighty loads of ice for the Ice House" were delivered to the manor house at Knowle (1992, p. 104). Later, as commercial and industrial demand for ice developed, overseas supplies were brought to London and the principal fishing ports to supplement domestic harvests.

A slippery speculation

The confectioners' Greenland iceberg proved slippery in more ways than one. As well as the practical challenges accompanying the transport of such a perishable commodity, it also threw up administrative ones, for ice also proved slippery conceptually:

> When the cargo arrived in the river, the Custom-house officers were, as usual, on the alert, and the ice-berg from which it had been abstracted, not having either a custom-house or an accompting-house erected on it, the customary bills of lading and clearance were wanting. This was not the only informality discovered in the case. The commodity being foreign, it was clear it should be entered at the Custom-house of London; but whether under the head of *produce* or of *manufacture*, was a very puzzling question. After much dispute, it was proposed to cut the knot, by entering the commodity as *foreign fabric*. … A compromise was, however, effected in time to prevent a premature dissolution (*The Times* 1822, p. 3, emphasis in original).

The arrival of this curious cargo evidently put Customs and Excise officials in a quandary. Moving goods across national borders depends on having the requisite paperwork attached to them. As 'foreign fabric,' matter not of Britain, ice had to be classified to enter. It failed to fit neatly into officials' existing schema and they struggled with where best to place a substance so 'foreign' to their accounting system until these knowledges, practices and organising systems stabilised sufficiently for ice to shift status once again and become a 'normal' import.

A modest trade in ice was already underway within the United States by this time starting, it is said, in 1799 with a cargo cut from a pond near Canal Street in New York and shipped to Charleston, South Carolina (Jones 1984, p. 93). Although a commercial ice business did not exist as such prior to 1800, by the mid-nineteenth century a well organised industry had emerged. Remarkably for such a highly perishable product, not to mention one formerly regarded as a free good that was "plentiful and useless," ice was to become a commodity shipped around the world, in large part due to Frederick Tudor's (1783-1864) unshakable conviction that exporting 'frozen water' to the West Indies would be a profitable enterprise (Dickason 1991, p. 60; Weightman 2003).

The Ice King and the frozen water trade

Tudor was nicknamed the 'Ice King' for initiating the substantial trade in natural ice which originated in Boston. He recognised the potential for export early on and, from 1805, kept a detailed account of the progress of his business in what he titled his *Ice-House Diary*. His first shipment was to St Pierre in Martinique, where he arrived in 1806 with 130 tons of ice aboard the *Favorite*, a vessel he was forced to buy himself after failing to find any other ship owners willing to carry his unusual cargo (Shachtman 2000, p. 62). His journey met with limited success. Without suitable storage facilities at the destination port, his cargo did not last long. Moreover, the local population was completely unfamiliar with ice, ice cream or iced drinks and had no knowledge of how to use or keep it. Tudor hurriedly undertook a public education exercise, producing and distributing handbills to explain its use and preservation. In a letter to his brother-in-law on March 10th, 1806, Tudor complained that:

> their methods of keeping it are laughable, to be sure. One carries it through the street to his house in the sun noon day, puts it in a plate before his door, and then complains that "il fond." Another puts it in a tub of water, a third by way of climax puts his in salt! and all this notwithstanding they were directed in the hand bill what to do (cited in Shachtman 2000, p. 63).

Tudor appeared frustrated by the local population's failure to adhere to his instructions. He had provided the necessary information about how to handle this product, and yet people were slow to put it into practice. The new knowledges associated with the introduction of this novel commodity had first to be translated into daily practice, and then to stabilise. Elsewhere he seemed more ready to acknowledge that the kind of sea change he sought to instigate takes time; "the object," he explains, "is to make the whole population use cold drinks instead of warm or tepid," estimating that "it will be effected in the course of three years." Although he lost most of the money he invested in the venture, Tudor learned two crucial lessons: first, business success would depend on effective storage to minimise wastage through melting; and, second, marketing and consumer education were essential to convince people of the benefits of ice, to build demand and promote new consumption practices.

A shipment to Havana the following year was more fruitful, but President Jefferson's 1807 embargo on trading with French and British colonies thwarted Tudor's plans to expand into the Caribbean. Over the following decade, Tudor started supplying southern US cities, such as Charleston, Savannah and New Orleans, which lacked natural ice sources of their own. Using promotional strategies to generate demand, like offering free ice for an initial period, he found residents quick to develop a taste for delicacies like iced drinks and ice cream (Shachtman 2000, p. 64). With such 'novelties' being adopted as the norm, ice shifted status and Jones (1984, p. 93) credits Tudor with turning ice into a necessity in these coastal areas.

One of Tudor's key strengths was his comprehensive understanding of the qualities and behaviour of ice. Through observation, detailed measurement and trial and error, he recognised the factors affecting melting rates and learned how to design ice houses and insulate ships more efficiently. The icehouse he built in Havana in 1816 proved conclusively that ice could be stored successfully not only in hot climates, but also above ground. Tudor benefited from collaborating with Nathaniel Wyeth in the mid 1820s. Wyeth's innovations in harvesting, such as the horse-drawn ice plough, revolutionised the industry. In his diary entries in 1827, Tudor spelled out the advantages of the uniform blocks of ice that this device produced, calculating that up to 17% more ice would fit in a ship's hold when was cut to a standardised shape and size (Dickason 1991, p. 62). The harvesting process began with scraping the ice clear of snow and cutting grooves into its surface to mark out a checkerboard of blocks. Wyeth's plough would then cut through the ice to about two-thirds of its depth, a process previously done by hand, and later by mechanical circular saws (Figure 2.3). A raft of blocks could then be separated off by hand and either floated along a channel or pulled up a chute onto a sleigh and hauled by horse to the icehouse. There they would be broken into individual cakes of ice, hoisted into the icehouse on horse-powered, and later steam-powered, conveyor belts and stacked in layers until the space was packed tight. A well insulated and well packed icehouse or cargo hold would result in very little loss by melting, permitting ice to be stored year round and transported thousands of miles across the globe.

Figure 2.3 Horse-drawn ice ploughs

© Canal Museum Trust, used with permission of the London Canal Museum

In 1833, Tudor turned his attention to Calcutta. The East India Company facilitated the Indo-American ice trade by granting Tudor special exemptions from import duties, and so it was that "Henry Thoreau watched Tudor's cutters working on Walden Pond and marvelled that water from his bathing beach was travelling halfway round the globe to become the beverage of East Indian philosophers" (Dickason 1991, p. 69; Shachtman 2000, p. 70). While the image is a compelling one, Dickason points out that it was not quite accurate, for the ice reaching India was consumed mainly by Anglo elites rather than by the Indian population. Although domestic ice consumption within Britain was limited, those British expatriates transplanted into an Indian climate provided a ready market for New England ice:

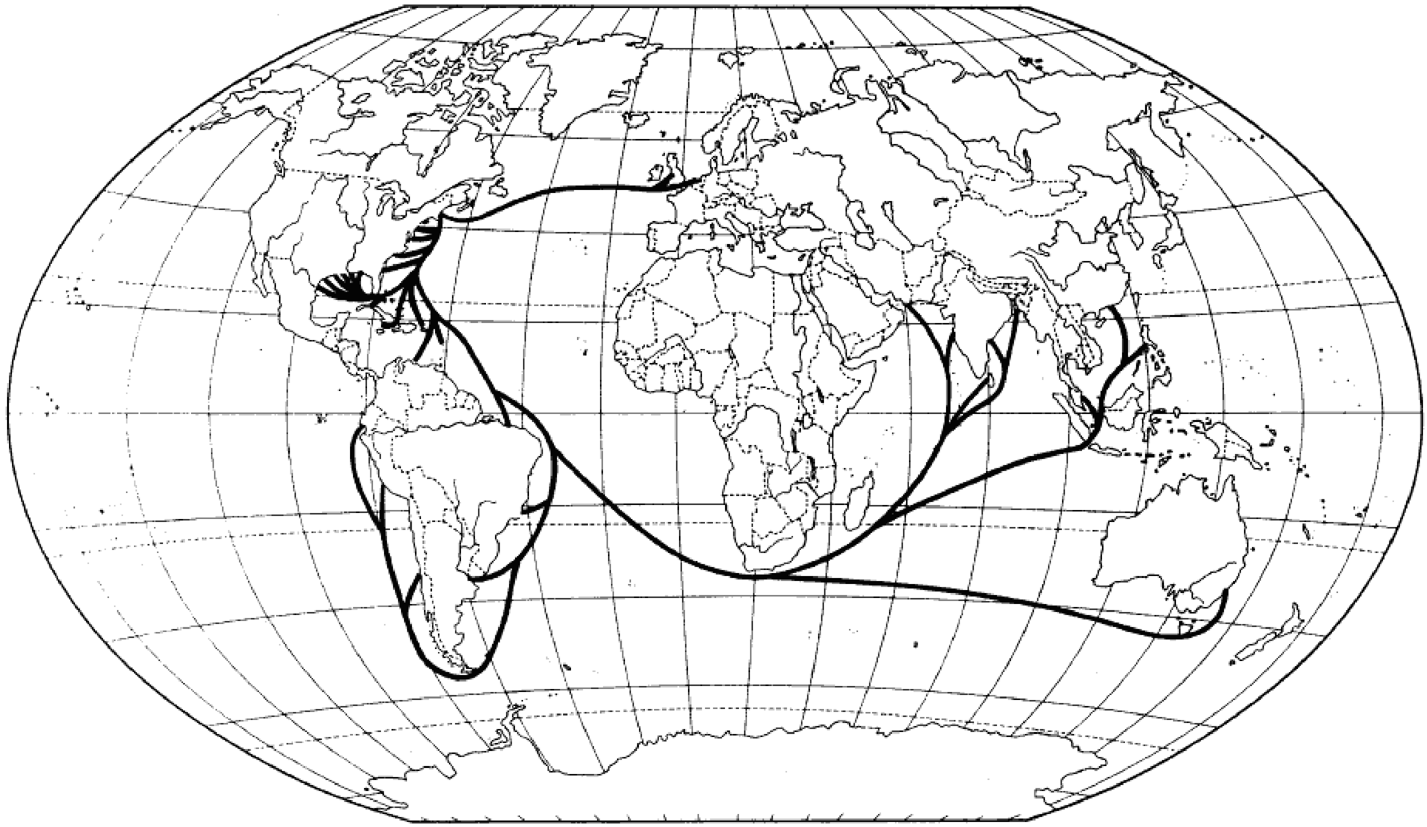
> The stoppage of the Bank of Bengal here could hardly exceed the excitement of a failure, during our hot weather, of the Ice! – and the arrival of our English mail is not more anxiously expected than that of an American Ice-ship, when supplies run low! (Grant 1862, p. 36).

The arrival of that American ice ship in India also finds its way into literature. In a story called 'The Undertakers' from Rudyard Kipling's *The Second Jungle Book*, the Adjutant Crane described his first encounter with this strange substance as he watched ice being unloaded into an ice house:

> "From the insides of this boat they were taking out great pieces of white stuff, which, in a little while, turned to water. Much split off, and fell about on the shore, and the rest they swiftly put into a house with thick walls. But a boatman, who laughed, took a piece no larger than a small dog, and threw it to me. I – all my people – swallow without reflection, and that piece I swallowed as is our custom. Immediately I was afflicted with an excessive cold …. Never have I felt such cold. I danced in my grief and amazement till I could recover my breath." … The Adjutant had done his very best to describe his feelings after swallowing a seven-pound lump of Wenham Lake ice, off an American ice-ship, in the days before Calcutta made her ice by machinery (Kipling 1911, pp. 154-5).

The ice trade grew slowly during its first two decades or so and in the 1830s Tudor's business was still virtually a monopoly. He secured cutting rights on lakes and rivers throughout New England and New York and gradually built up a huge distribution network of ships, ice houses and agents and – eventually – after struggling financially for many years, ice did prove profitable for him. The reach of Boston's ice is striking (see Figure 2.4). Following Tudor's shipments to Martinique in 1806 and Calcutta in 1833, ice was exported to Rio de Janeiro in 1834, Sydney in 1839, London in 1842 and reached Yokohama, Japan, in 1854, after six months at sea. As consumption grew domestically and overseas, other companies entered the ice business and by the 1870s thousands were employed in an international natural ice industry.

Figure 2.4   The Ice Trade c. 1856



Source: Dickason 1991, p. 58

The eventual decline of New England's ice industry came about for a number of reasons, not least of which was the development of artificial means of making ice. From the mid 1870s, New England's winters grew warmer than they had been earlier in the century. The quantity of ice diminished, along with its quality as rising industrialisation led to increased pollution. For a time, Boston had also benefited from being a port into which more cargo was imported than exported. As departing ships required some kind of ballast, ice merchants were usually able to get much lower freight rates on shipments out of Boston than they would have had elsewhere. This enabled them to sell their ice more profitably and help maintain Boston's ice monopoly, until the rise of New York's port supplanted Boston's position and curbed availability of such advantageous rates (Dickason 1992, p. 64; Albion 1939).

Importing cold

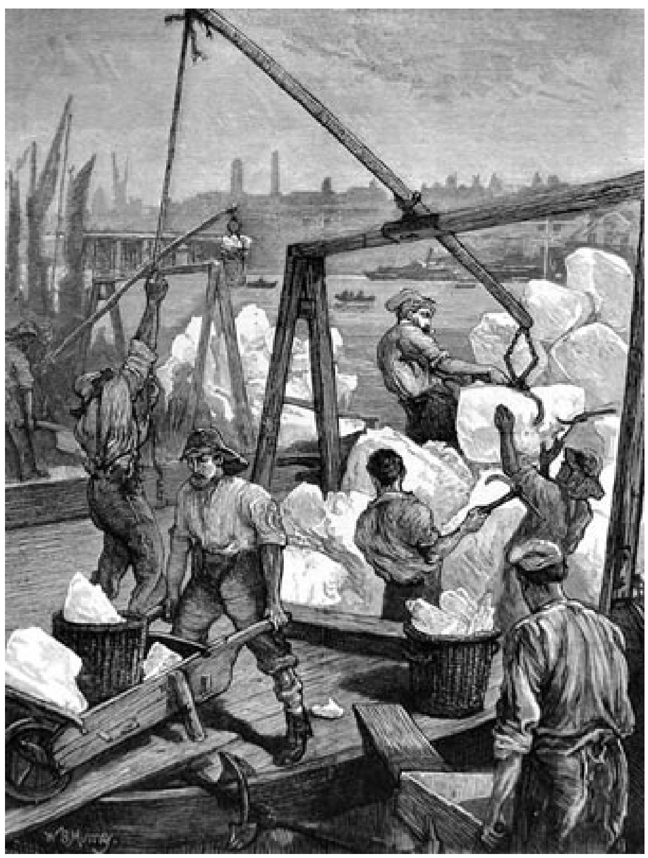
In his 1872 book *Healthy Homes*, William Eassie alludes to the social, economic and technological changes in ice use in Britain. He refers to a time when:

> the only ice we could muster upon these shores was drawn from our own waters – the nobleman revelling in the clear blocks drawn from his own spring-born lake, and the tradesman enjoying, in a lesser degree, the more impure ice-crusts of the village roadside pond (Eassie 1872, p. 206).

In this image, the origin of the ice supply, and thus its grade, map directly onto socioeconomic status, but Eassie goes on to speak of change, both in the sources of ice and in who got access to it. He talks of the 'importation of cold,' referring to a shift that started in the early 1820s when ice was first brought to Britain from overseas. In this process, we witness the transformation of frozen water into a commodity, we see it crossing greater physical distances as it is imported from Norway and the United States, instead of sourced from those local lakes and roadside ponds, and we also observe a degree of 'democratisation' as it travelled, in effect, across greater social distances. Expanding beyond the domestic spaces of the wealthy, ice became accessible to a broader range of consumers. No longer exclusive to "the squires' gardens," Eassie tells us that ice wells are more likely erected by the dealers who supply the fishermen and fishmongers and from whom domestic users would have purchased their supplies. Changes in scale were apparent not only in the greater distances that ice was carried as it was traded across international borders, but also in the spaces and the manner of its storage, for these both expanded into large commercial ice stores and, as I discuss in the next chapter, also contracted into ice boxes for individual household use.

Norway became the primary source of Britain's ice imports and ice ships journeyed back and forth between Norway and ports such as London, Hull and Grimsby to maintain a constant ice supply (Figure 2.5). Britain's rivers and the network of canals constructed during the Industrial Revolution provided the means for ice to reach other industrial centres inland. Most ice arrived at Regent's Canal Dock in London (now called Limehouse Basin) where it was unloaded onto barges and taken up the Regent's Canal to be stored in ice wells. Dealers began establishing large commercial ice stores. By 1830, one had been constructed under London's Haymarket to hold up to 1500 tons and Eassie refers to an ice well near Islington with capacity for 3000 tons (Hardyment 1992, p. 104; Eassie 1872, p. 206).

Figure 2.5 Engraving showing Norwegian ice being unloaded at the London Docks, 1874



Carlo Gatti (1817-78) was an Italian-Swiss immigrant who came to London in 1847 and entered the restaurant business. Best known for his ice cream, Gatti also traded as an ice merchant. He harvested ice locally under contract with the Regent's Canal Company and, in 1857, began importing ice from Norway. Gatti's depot was located next to the Regent's Canal on New Wharf Road, now the site of London's Canal Museum. Here, he excavated ice wells forty feet deep and, above them, stables for his fleet of delivery horses.[20] The ice wells remained in use until 1902, by which time The United Carlo Gatti, Stevenson and Slaters Ltd had grown into the largest firm in London dealing in natural ice. The company continued trading into the 1920s, by which time it had ceased importing and switched to making ice artificially.

Ice also came from further afield in the 1840s, when Boston traders looked to Britain as a potential market. The company Gage, Hittinger & Co. made an initial shipment in 1842, carrying ice from Fresh Pond, Cambridge, to London aboard the *Sharon*. The arrival of this cargo was promoted in *The Times*, but sales proved much slower than had been hoped[21]; as Tudor himself had stressed, ice was always unsuccessful when initially introduced into a new market and demand grew only later (Smith 1962). The most famous source for New England ice was Wenham Lake. On July 9th 1844, the *Ellen* docked in Liverpool, as reported in the 'Shipping Intelligence' column of the *London Morning Chronicle* the following day. Aboard was Britain's first cargo of Wenham Lake Ice, shipped by Charles Lander of Salem, Massachusetts (Smith 1962). Before long, Wenham Lake ice became a sought-after commodity on the dinner tables of wealthy Britons. Reputed for its purity, Wenham Lake Ice was advertised as fit for 'table use,' that is, it could be consumed with food and drink, in contrast to certain other sources not considered sanitary enough for consumption or for direct contact with food. Smith includes a contemporary description of the reception of the so-called 'Crystal Blocks of Yankee Coldness':

20 The wells and weighing bridge where ice would be loaded onto carts for delivery have been preserved by the London Canal Museum. The museum took over the site in 1989 and tells the history of the British ice trade (http://www.canalmuseum.org.uk).

21 Hall (1888, p. 3) writes that "it is said that fancy iced drinks, so common in the United States, were then almost unknown in England. In order to promote the consumption of the article he had to sell, Mr Hittinger exported several competent bar-tenders from the United States to England and introduced fancy drinks there."

> This commodity which was first introduced to the notice of the English public a short time ago through the medium of the Liverpool Press, is so rapidly advancing in popularity in the metropolis that no banquet of any magnitude is considered complete without it. … Not only is the Wenham Lake ice coming into vogue as a luxury among the aristocracy, but it is also recommending itself to the middle classes as a necessity, and even to the humbler ranks of life as an article of economy. As a preservative of food, whether in a raw or a cooked state, it is of the greatest possible utility, the price of the ice being nothing compared with the value of the provisions it secures against corruption (Smith 1962).

The geographies of this particular trade got tangled in some interesting ways with one of the ice industry's more creative marketing campaigns. It was widely held that ice from Wenham Lake was superior in quality to that harvested elsewhere. In practice, the major difference between American and Norwegian ice may have principally been price, ice from Norway being cheaper because its shipping costs were lower. Blain (2006) explains that *Morgenbladet*, a Norwegian daily newspaper, carried a report in December 1864 that a foreign entrepreneur had purchased Lake Oppegård in southeast Norway, near Oslo, and renamed it Wenham Lake so as to be able to sell the ice harvested there as 'Wenham Lake ice.' The amount of ice imported from the United States was never large, and most came from Norway thereafter.

By the mid nineteenth century, a taste for ice had grown and Eassie's figures indicate that imports increased fifty-fold over a period of fifteen years, from 2000 tons in 1854 to over 100,000 tons in 1869 (1872, p. 206). At the turn of the century, Britain was importing half a million tons of ice and it was regularly landed at more than twenty British ports, though nearly half the total imports were consumed in the capital (Fussell 1956, p. 131; Thévenot 1979, p. 23). The 1898 figures from the *Cold Storage Review* show a total of 190,000 tons arriving in London, followed by other major east coast ports such as Grimsby (75,000 tons) and Hull (25,000 tons), while the major urban centres to the west, Liverpool and Glasgow, both received around 14,000 tons (Fussell 1956, p. 355, citing *Cold Storage Review*, July 15th, 1899). While a Special Consular Report on *Refrigerators and Food Preservation in Foreign Countries*, published in the United States (United States Department of State 1890), confirmed that the majority of towns received most or all of their ice from Norway, a couple (Liverpool and Plymouth) reported that a small amount of ice was being manufactured locally. Levels of artificial ice production were higher in London, but this primarily supplied breweries and commercial cold stores, so ice consumed in London homes still came principally from Norway.

By the end of the nineteenth century, the trade in natural ice had peaked and gone into decline. Imports dwindled as ways of creating cold increasingly became mechanized. By 1910, shipments from Norway had fallen to 300,000 tons and down to 200,000 tons by 1914. Likewise, harvests of natural ice in the United States dropped from a peak of 25 million tons in the late 1880s to 15 million tons by 1907. Harvests fell off sharply after 1910 and the industry was virtually dead by the 1920s (Thévenot 1979, p. 67; Jones 1984, p. 14). It was no coincidence that this was also the time when domestic refrigeration was starting to take off in the United States. Although it was somewhat later before refrigeration became widespread in Britain, consumption of natural ice waned in the face of competition from artificial ice, whose manufacture had grown both cheaper and more reliable. The last ice shipments arrived in Britain in 1933 (Fussell 1956, p, 357). It was perhaps fitting, therefore, that the Science Museum should choose the following year, 1934, to devote one of its periodic temporary exhibitions to the theory and practice of mechanical refrigeration.

In order to explain the development of mechanical cooling devices, we need to rewind and pick up the story again with early enlightenment science. In this next section, I sketch out key moments in the evolution of theorising heat and trace some of the strands of research that coalesced into a science of thermodynamics. Knowledge of the properties of heat was needed to answer the question of how artificial cooling could best be achieved:

> It may be regarded as a remarkable fact that the substance which is more abundant and easily obtained than any other in the world should happen to freeze at the precise temperature which modern science has found to be the best suited for preserving fresh meat … and should, while changing from the solid state, ice, produce a greater refrigerating effect than almost any other known substance. Ice, in fact, seems so well adapted for the preservation of food that it is not surprising to find that the earlier refrigerating machines were designed less with the idea of producing cold than for making ice artificially to supplement natural supplies (Crawhall & Lentaigne 1934, p. 6).

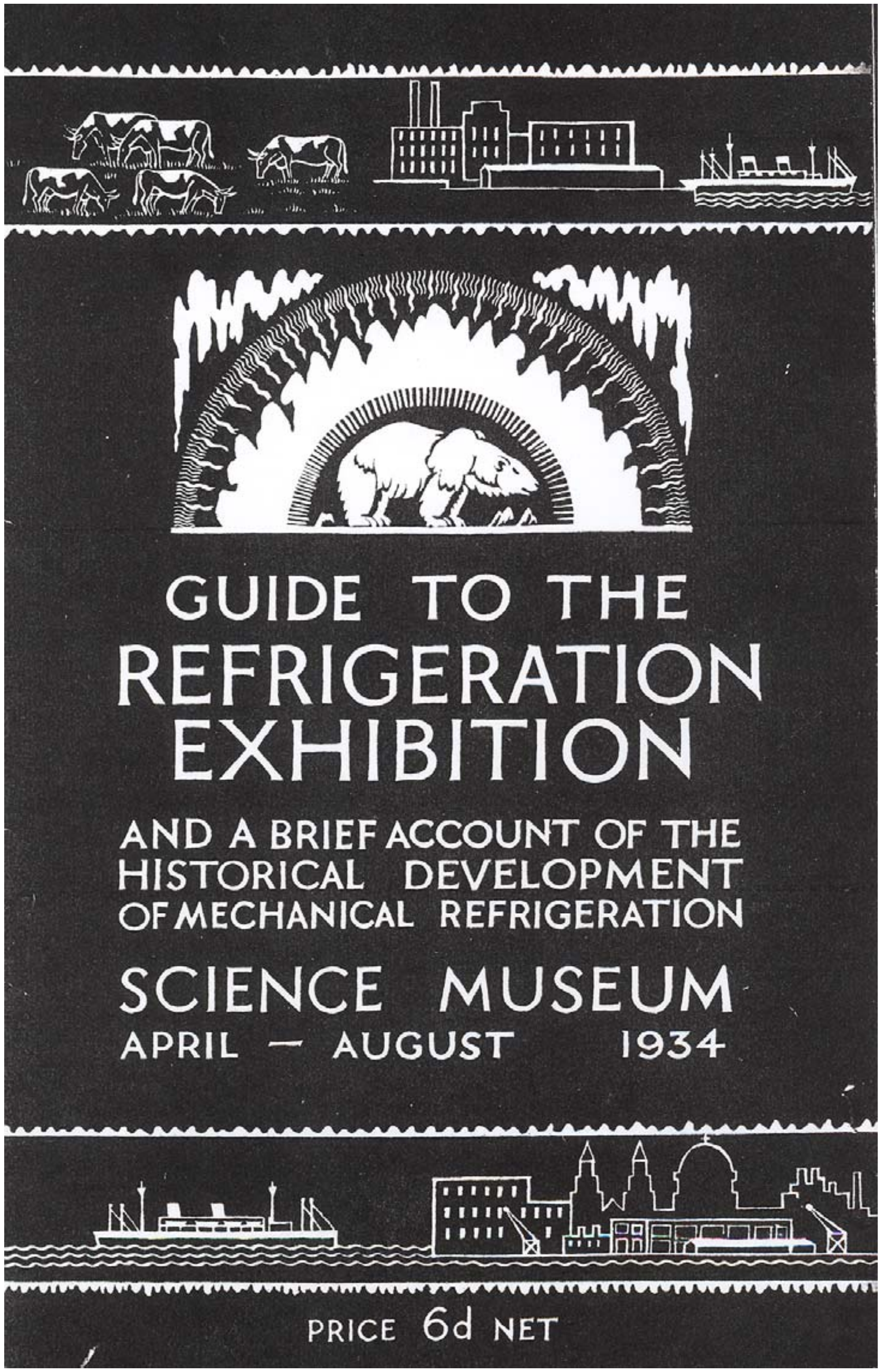
For people to reorient their thinking from making ice to making 'cold,' in just the way that Trevithick had contemplated in his 1828 letter, a significant conceptual leap was required.

THE THEORY AND PRACTICE OF MECHANICAL REFRIGERATION

The Science Museum's refrigeration exhibition was organised in collaboration with the British Association of Refrigeration (BAR) and ran from March to August 1934. It was intended to be appropriate for a range of audiences and to appeal both to visitors with technical expertise, such as BAR members and those in the industry who would have seen the exhibition announced in the journal *Ice and Cold Storage*, as well as to the general public.

The image on the cover of the exhibition guide centres on the polar regions and depicts a stylised icy landscape complete with polar bear, a wild cold world that, as it were, refrigeration had domesticated (Figure 2.6). The panels above and below the image, expanded versions of which were reproduced on banners on the gallery walls, evoke a series of journeys. Ships equipped, we can surmise, with refrigeration equipment form the thread linking the various landscapes. These ships symbolise the trade and transport networks constructed to carry the 'fruits' (and meats and dairy products) of the farming industry and processing factories above to the complex urban centres below, with their docks and cranes and warehouses, their civic buildings, office blocks, shops and homes. These journeys are not simply physical voyages from A to B across the oceans. They are also journeys through cycles of production and consumption, and journeys representing the idea of progress in science and technology. The exhibition was very much intended as a celebration of the innovations that had 'conquered' cold, 'triumphed' over time and space and shrunk the world sufficiently to put Antipodean beef and butter into British bellies.

Figure 2.6 Cover of the Science Museum's Refrigeration Exhibition Guide (Crawhall & Lentaigne 1934)



©Science Museum, used with permission

As they walked around the exhibition, visitors would have been introduced to the cast of characters populating the history of mechanical refrigeration, 'the men who created cold,' to borrow the title of Woolrich's history (1967). And, indeed, they were all men. The worlds of science and engineering were then, as now, strongly gendered masculine. Men were routinely the scientists, engineers, traders and investors while women were represented as entering the equation only later, 'downstream,' as recipients and users, not as innovators. We have no way of knowing now exactly who visited the exhibit or what they learned from it. It was certainly intended to be open to everyone, and took up a space of 3000 sq ft positioned prominently near the museum's main entrance, but when Mr Pearson from Electrolux wrote to the museum in March 1934 about arrangements for the exhibition's formal opening, he requested that invitations be sent to three Electrolux Directors, adding that "I do not think there is any need to include ladies in your invitations."[22] It is unclear if Pearson believed refrigeration to be a topic of little relevance or interest either to women in general, or to the directors' wives in particular, but even though organisations such as the Electrical Association for Women (explored more fully in chapter 3) were taking active steps to educate and promote an interest among women in matters electrical, the vast majority of visitors with either a professional interest or a technical background in this field would invariably have been men.

The museum officer in charge of arranging the exhibition was Thomas Crawhall, who also co-wrote the exhibition guide. Crawhall and Lentaigne described the process of producing cold artificially as a critically important but relatively recent scientific accomplishment (1934). Both the exhibit and the accompanying guide, *A brief account of the historical development of mechanical refrigeration and a descriptive catalogue of the exhibits, with notes on the basic scientific principles*, opened with the observation that the multiple ways in which the term 'heat' tended to be used, and longstanding confusion about and slippage between the concepts 'heat,' 'temperature' and 'energy,' were responsible for muddying popular understandings of thermal processes (Crawhall & Lentaigne 1934, p. 3).

22 Letter from C. H. Pearson at Electrolux to T. C. Crawhall at the Science Museum, March 21, 1934 (archived in Science Museum Nominal File 4719 [1962-98] Electrolux Ltd.).

(Mis)understanding heat and cold

Published in 1627, Bacon's treatise of natural history, *Sylva Sylvarum, Or, a Naturall Historie in Ten Centuries* has been described as a "curious rag-bag of facts and fables," but Thévenot points out that it includes some of the earliest analysis of the nature of cold (Broad 1926; Thévenot 1979, p. 393). It represents a perspective shaped by the belief that while people could produce heat, the ability to produce cold was beyond human means:

> Heat and cold are Nature's two hands whereby she chiefly worketh; heat we have in readiness in respect to fire, but for cold we must stay till it cometh or seek it in deep caves and when all is done we cannot obtain it in a great degree (Bacon 1627a)

Appended to the *Sylva Sylvarum* is *The New Atlantis*, Bacon's 'science fiction' fable about an imagined futuristic community of Bensalem. In it he refers to Bensalem's inhabitants being able to manipulate the seasons to make flowers bloom or trees bear fruit out of season. He also talks of experiments to thicken, harden, chill or preserve substances being carried out in caves

> remote alike from the sun and heaven's beams, and from the open air. These caves we call the lower region. And we use them for all coagulations, indurations, refrigerations, and conservations of bodies (Bacon 1627b)

In Bacon's view, cold spaces, cold materials or cold conditions could certainly be put to use, as exemplified by his chicken preservation exercise, but cold could not itself be conjured into being at will. For him, such an idea remained in the realm of fantasy. Woolrich draws attention to the obstacle of a long-standing climate of religious disapproval and hostility that early scientists and thinkers faced when attempting to do research in this field. Many regarded such work as challenging dominant belief systems by questioning or attempting to contravene a supposed divine order of hot and cold regions of the world. He commends the bravery of these early contributors to the evolving sciences of thermodynamics and refrigeration, suggesting that to those "who pursued their inquiries in defiance of superstition and censure belongs worldwide appreciation for their contributions" (Woolrich 1967, p. 20). The concept of creating cold was a contentious one for both these reasons and to accept it required a profound shift in thinking. For such a practice to be conceivable, a more sophisticated understanding of the nature and behaviour of heat was necessary.

Robert Boyle (1627-1691), a natural philosopher from Ireland and founding member of the Royal Society, is best known for his work on gases, his research on the properties of air and the experiments he conducted using air pumps, upon which his 1660 publication, *New Experiments Physico-Mechanicall, Touching the Spring of the Air and its Effects*, was based (see Shapin & Schaffer 1985). Less well known is his extensive work on cold. Considering cold to be a topic that had long been overlooked, Boyle (1665) regarded this as an "invitation [to] repair the omissions of mankind's curiosity toward a subject so considerable." He undertook hundreds of experiments exploring the effects of cold and its methods of transmission and, in 1665, published his findings in a book entitled *New Experiments and Observations Touching Cold*. Woolrich (1967) points to this as the first detailed scientific examination of cold and it seems that Boyle himself envisioned his work as laying the foundation upon which a comprehensive science of cold could subsequently be built, for the full title of his book continues, *An Experimental History of Cold Begun*. His research on gases led to the formulation of Boyle's Law, which explains that the volume of a gas at constant temperature varies inversely with pressure; hence, a reduction in the volume of a gas is accompanied by an increase in its pressure and, conversely, an increase in volume brings about a proportional decrease in pressure. This would eventually come to have great significance for artificial refrigeration even though "nearly two hundred years would pass before the relationship between pressure and volume that Boyle described became the cutting edge of cold research" (Shachtman 2000, p. 26).

Measuring temperature

In the meantime, the ability to measure temperature was one important step on this journey. It is possible to raise the temperature of something by bringing it into contact with something hotter. Two bodies left in contact with each other will come to thermal equilibrium, that is, they will eventually reach the same temperature, and this is the principle upon which a thermometer works. The Italian astronomer and physicist Galileo Galilei (1564-1642) developed an early form of thermometer, strictly an 'air thermoscope', around 1597. Its reliance upon air was found to be one of its limitations and once it was realised that air pressure varied according to location, altitude and even weather conditions, the search for an appropriate alternative became a central concern in thermometry; alcohol thermometers were being used in Florence by the mid 1600s and by 1714 Daniel Fahrenheit (1686-1736) had turned to mercury.

Galileo's thermoscope also lacked a scale. It could indicate a rise or fall in temperature, but the notion of precise units or quantities of heat had yet to be developed. There had been various early attempts to establish some kind of scale but these tended to be fairly arbitrary. However, until scientists had the means to measure what they were observing, the scope of many of their experiments remained limited. A scale could not be meaningful until it was tied to a series of fixed points, the establishment of which became thermometry's second key challenge. Some of the fixed points proposed in the late 1600s included the temperature of a kitchen fire hot enough for roasting; the temperature at the height of summer in Italy, Syria or Senegal; the boiling points of water or pure alcohol; the temperatures at which wax or butter melt, or at which aniseed or linseed oil congeal; the temperature of the human body; the temperature of a salt/ice mixture; or that of the deepest cellar under the Paris Observatory (Shachtman 2000, p. 43-44). Such suggestions raise fascinating questions about the hottest and coldest places or substances that could be imagined at the time, and about how temperature was understood to relate to particular bodies and locations. Guillaume Amontons (1633-1705) was among the first to use the temperatures at which water changes state as fixed points (Thévenot 1979, p. 25). This idea might seem entirely logical now, but it is important to recognise that the suggestion was controversial at a time when no consensus existed that freezing or boiling points were constant, many believing them to vary according to location, season and even time of day (Shachtman 2000, p. 43). Fahrenheit is credited with introducing a standardised scale for thermometers, on which melting ice was measured at 32°F and boiling water at 212°F. Anders Celsius's 100 division centigrade scale was introduced in 1742 and its name was later changed to degrees Celsius in his honour.

Even when reliable thermometers were available in the early eighteenth century, Thévenot points out that accurate understandings of heat took much of the next century to 'catch up' (1979, p. 28). The confusion about heat that Crawhall and Lentaigne referred to should not be surprising given that historically the term was used in different ways and measured in different units. Assorted theories of heat circulated at various times and for much of the eighteenth century two principal competing theories coexisted, one a 'material' explanation of heat, the other a 'mechanical' explanation.

Competing material and mechanical theories of heat

The French chemist Antoine Lavoisier (1743-1794) made important contributions to chemistry through his work analysing gases and liquids and, in 1783, put forward a Caloric theory of heat. This theory conceptualised heat as a material substance, an invisible and weightless "subtle fluid" or "imponderable fluid" called Caloric. It was the presence, or absence, of this substance that made a body hot, or not. Lavoisier was therefore able to argue that the three states in which matter existed, as a solid, liquid or a gas, depended on the degree of 'fire matter' they contained (Thévenot 1979, p. 444). Particles of heat were understood to repel one another but to be attracted to particles of other matter, which offered a convincing explanation as to why a warm substance, such as a cup of hot coffee, cools down when left at room temperature. Heat would 'flow' from warmer to colder substances, so from the coffee into the air, as heat particles were drawn to other substances and away from their own kind, the result being an equalisation of temperature. Although not as widespread, some also subscribed to a parallel idea that cold was a fluid called Frigoric. Judged to be a unified and comprehensive explanation of heat, Caloric theory was widely adopted in scientific circles and prevailed for much of the next century. For a time, it seemed a sufficiently elastic theory to explain all heat-related processes. Obviously, this presented something of a stumbling block for those attempting to advance alternative conceptions of heat or cold and progress in understanding cold was inhibited until Lavoisier's theory of heat was disproved.

Though dominant, caloric was not a universally held view. Some continued to subscribe to longstanding mechanical theories which held heat to be not a material substance but something produced by the motion of particles of matter. Dating back at least to ancient Greek thought, and mentioned by Plato, this idea was discussed by Bacon in his *Novum Organum* (1620), where he suggests that "the very essence of heat … is motion, and nothing else." Benjamin Thompson (1753-1814), better known as Count Rumford of Bavaria, made a critical observation towards the end of the 1700s that led him to challenge Lavoisier's position. When boring metal he noticed that friction seemed to produce unlimited quantities of heat. If heat was, as Lavoisier claimed, a substance, the amount contained within the metal should be finite. This prompted him to ask the question:

> What is Heat? … Is there anything that can with propriety be called caloric? … [T]he source of the heat generated by friction, in these experiments, appeared evidently to be *inexhaustible*. It is hardly necessary to add that anything that any insulated body … can continue to furnish without limitation, cannot possibly be a material substance; and it appears to me to be extremely difficult, if not quite impossible for form any distinct idea of anything capable of being excited and communicated in the matter the Heat was excited and communicated in these experiments, except it be MOTION (Thompson 1798, p. 88).

Caloric theory could not adequately explain this phenomenon for it was unable to account for a transformation of mechanical energy into heat. The significance of Thompson's work would later be acknowledged, but, when first published, its impact upon caloric theory was negligible. Part of the problem was Thompson's difficulty in quantifying his findings. That was to be James Joule's (1818-1889) contribution in the 1840s. Joule's success in making a convincing case for a kinetic theory of heat lay in his ability to measure the work performed and the heat produced. He showed that 'heat' and 'work' could be measured in the same units and, in so doing, demonstrated that they were interchangeable forms of energy (Goldstein & Goldstein 1993, p. 53-5). This principle of mechanical equivalence, the notion that work and heat are the same, became the First Law of Thermodynamics. As with any innovation, it is often difficult to disentangle precisely who discovered what and when so the First Law tends to be jointly attributed to Robert von Mayer (1814-1878) and Joule. Mayer explored the idea in his writings in 1842 and Joule published an experimental proof at around the same time, hence it came to be known as the Joule-Mayer principle.

It was at the annual meeting of the British Association for the Advancement of Science in Oxford in 1847 that William Thomson (1824-1907), later known as Baron Kelvin after he was honoured for his scientific achievements with a peerage in 1892, heard Joule's presentation on an alternative to caloric theory. Although it took some time before Kelvin was convinced by a mechanical conception of heat, he was interested enough in Joule's ideas to begin a correspondence and collaboration with him over the next few years. Together, the ideas and observations of Rumford, Mayer, Joule and Kelvin gave rise to the recognition that heat was a product of molecular motion. This kinetic understanding was eventually accepted, superseding caloric theory by the late nineteenth century. Heat is not a material form, as caloric theory had assumed it to be, but a process. This led, in turn, to new understandings of cold. Cold was not a substance but, in effect, an absence – an absence of heat, an absence of molecular movement. The quality of 'coldness' could therefore now be conceptualised as something caused not by adding cold but by removing heat.

Changing the state of matter

Matter exists in three states – as a solid, liquid or gas – depending on how closely together its particles are arranged. As a substance absorbs thermal energy, the kinetic energy of its molecules increases. 'Temperature' is, therefore, a measure of how fast molecules are moving. When thermal energy raises the temperature of a substance it is known as 'sensible heat,' that is, it can be sensed. However, under certain circumstances, a substance can absorb heat without any change in temperature. This is known as 'latent heat,' a concept developed in 1761 by Joseph Black (1728-1790), a professor of physics at Glasgow University. During his experiments on evaporation and condensation, Black noticed that even though ice absorbed a considerable quantity of heat from its surroundings as it melted, its temperature remained unaltered. At the point when ice turns into water, or water into steam, the two forms coexist at the same temperature. The energy it absorbs, instead of altering its temperature, is used to fuel its change of state by supplying molecules with sufficient energy to overcome the force of cohesion and break away into a looser bond. Although it cannot be detected through temperature, latent heat is not lost. It remains 'hidden' until the transformation is reversed, at which point this stored energy is released once more as sensible heat. Thus, sensible heat becomes latent as ice melts or water evaporates, but is released when it reliquifies or resolidifies. The key point here is that whenever matter changes state, energy is either absorbed or released. As Crawhall and Lentaigne emphasise:

> the property of absorbing heat without changing temperature forms the basis of nearly all refrigerating processes and is found even in the most simple and primitive forms of apparatus, the makers of which may be quite ignorant of the thermal processes involved (1934, p. 3).

Users may 'know,' for example, that water in a dish left out in the sun will heat up if the dish is glazed, but cool down if it is porous, without necessarily understanding that this happens because water seeps through the container and evaporates into the surrounding air by drawing energy from the water remaining in the vessel.

Following this logic, it is possible to bring about a change of state deliberately by supplying or extracting heat. It had long been speculated that certain gases could be condensed into liquids but the first person to achieve this experimentally was the Dutch physician and physicist, Martin van Marum (1750-1837), who, towards the end of the 1780s, managed to liquefy ammonia. Michael Faraday (1791-1867) was best known for his work on electricity but he also made important contributions in this field. In a presentation to the Royal Society in 1823 he described the method he had used to create a liquid form of chlorine gas (Faraday & Davy 1823). It was subsequently found that all gases could be liquefied by subjecting them to sufficient pressure and/or low enough temperatures. Over the next two decades, Faraday was able to liquefy most of the known gases by using a mixture of snow, ether and dry ice (the solid form of carbon dioxide) to achieve the extremely low temperatures that were necessary.

Access to these liquified gases was crucial for progress in mechanical refrigeration. These liquids extract heat from their surroundings in order to fuel their return to a gaseous state and, because they boil at such low temperatures, the effect is to draw heat away from already cold regions, which, in giving up their heat, become colder still. One outcome of Kelvin's collaboration with Joule was their discovery of the Joule-Thomson Effect in 1852. This refers to the temperature drop that occurs with the sudden expansion of a gas when released from high pressure to low pressure, a finding which would prove to be highly significant for developments in refrigeration. Though it was not something he was to pursue himself, Faraday certainly recognised the potential applications of this cooling effect and commented that "there is great reason to believe that [this technique] may be successfully employed for the preservation of animal and vegetable substances for the purposes of food" (Shachtman 2000, p. 66).

Heat engines, heat pumps and the Second Law of Thermodynamics

The year after Faraday liquefied chlorine, the French engineer Sadi Carnot (1796-1832) published a manuscript detailing the changes of state that take place within a thermodynamic cycle. Carnot's primary interest was in making steam engines more efficient. He knew of Trevithick's work developing the first high pressure steam engine and in his text, *Reflections* *on the motive power of fire, and on the machines Fitted to Develop this Force* (1824), Carnot describes the cycle of a perfect heat engine.

In a thermodynamic cycle, a system passes through one or more changes of state before returning to its initial state. His theoretical 'Carnot Cycle' represents the most efficient cycle for converting thermal energy into mechanical work and Carnot showed that for a steam engine to perform mechanical work, heat must move across a temperature differential from a body at a higher temperature to one at a lower temperature. The bigger the temperature difference between the two, the greater the work the engine can perform. He set out the principles upon which this process operated:

> Wherever there exists a difference of temperatures … it is possible to have also the production of impelling power. … All substances in nature can be employed for this purpose, all are susceptible of changes of volume, of successive contractions and dilatations, through the alternation of heat and cold. All are capable of overcoming in their changes of volume certain resistances, and of thus developing the impelling power. A solid body … alternatively increases and diminishes in length …. A liquid alternately heated and cooled increases and diminishes in volume, and can overcome obstacles of greater or less size, opposed to its dilatation. An aeriform fluid [a gas] is susceptible of considerable change of volume by variations of temperature. If it is enclosed in an expansible space, such as a cylinder provided with a piston, it will produce movement of great extent (Carnot 1824, cited by Goldstein & Goldstein 1993, p. 114).

In principle, any substance can be used in a heat engine. The work produced depends on the ability of a substance to change shape or volume and the extent to which it exerts force upon its container, or upon objects with which it is in contact, as a result of changing temperature. Work is performed by these changes of state, specifically by the movements which take place on a micro scale and determine how much space a substance occupies.

What is of particular interest here is that Carnot goes on to ask what would happen if the system were to be reversed. Heat is drawn in during one part of Carnot's cycle and eliminated in another. Given that these quantities are equal, he concludes that, in principle, the system is completely reversible; heat could simply be eliminated earlier in the cycle and taken in later. A heat engine run in reverse creates a refrigerator, which is a heat pump with the capacity to transfer heat from a cooler to a warmer space. Instead of converting heat into work, as in a steam engine, work is used to remove heat. However, it does not do so freely. An energy cost is exacted for moving heat from cold to hot, meaning that only part of the heat can be converted into work. Energy cannot be destroyed, but a portion of it remains unavailable for use; “in return for the work input to operate it, [a refrigerator] removes heat from a cold region and discards it to already warm surroundings” (Goldstein & Goldstein 1993, p. 120). Carnot argues that no such system exists in nature for energy can never travel from a cooler to a warmer substance without some external intervention. Heat, like water, will not freely flow ‘uphill.’

The significance of Carnot’s scholarship only became apparent after his death when developed further by the German physicist Rudolf Clausius (1822-1888) and by Kelvin. Posthumously, Carnot was embraced as a foundational figure in thermodynamics and his text became central to the canon because within it he had put forward the basis of the Second Law of Thermodynamics (Thévenot 1979, p .435-6). Carnot had articulated the ‘second’ law, in advance of what became the ‘first,’ but Clausius reformulated it more clearly in 1850 when he explained that it is impossible for heat to pass spontaneously from a cooler to a hotter body, which has since come to be known as the Carnot-Clausius principle (Goldstein & Goldstein 1993, p. 122). Carnot’s publication never reached a large technical audience and its influence on the design of engines was marginal at best, but Goldstein and Goldstein maintain that the importance of Carnot’s discovery of the Second Law of Thermodynamics, “is not so much what it tells us about heat engines, but rather what it tells us about the properties of matter” (1993, p. 112, 131). By understanding and manipulating the properties of matter on a micro scale, a refrigerator can be made to achieve something quite profound. It circumvents the Second Law of Thermodynamics by compelling heat to travel in the opposite direction, and today’s refrigerators still operate according to the principles of a reversible heat engine set out by Carnot in 1824 (Crawhall & Lentaigne 1934, p. 4).

First steps in artificial refrigeration

‘Chemical refrigeration’ was an important interim step between natural and mechanical refrigeration. Well before the advent of mechanised cooling, it was known that adding certain salts to water or snow had a cooling effect and could significantly lower the temperature at which water freezes.[23] As salt dissolves it absorbs heat from the water and reduces the overall temperature of the solution. Bacon set out formulae for refrigerating mixtures in his writings in the early 1600s and also makes reference in *De Augmentis Scientarium* (1623) to an "experiment of artificiall [sic] freezing" at Westminster, believed to refer to Cornelis Drebbel's (1572-1633) demonstration of a method of chemical cooling device in 1620. Drebbel claimed he could create winter in summer by chilling the air in a room. He was challenged to perform this feat for King James I in the Great Hall of Westminster Abbey and did so by constructing a crude refrigeration/air conditioning system (Shachtman 2000, p. 1). The details are difficult to establish as Drebbel left no record of his own but in Bacon's brief second hand account, he postulates that Drebbel used 'nitre,' a term for saltpetre, which would have been familiar to scientists at that time. Shachtman speculates that Drebbel would have filled metal troughs with water then added nitre, salt and snow to create a refrigerating mix which could drop below the temperature at which water freezes (2000, p. 14). This would have had a chilling effect on the containers and the surrounding air. Drebbel would have understood that warm air rises, a phenomena already observed by scientists at this time. The production of cool air would displace the warm air and make the lower part of the hall feel significantly colder. The demonstration seems to have been a success since Bacon's sources allege that it became "so cold on a summer's day that the King and his nobles and many great lords were forced to flee."

Boyle investigated these mixtures further in his research in the 1660s and Fahrenheit used a mixture of this kind as a way to achieve the lowest temperatures then possible in order to set the low point on his thermometer scale (Thévenot 1979, p. 24). The knowledge that mixing snow or ice with certain salts could create very low temperatures was not just restricted to scientific texts, but in the nineteenth century also circulated in more accessible forms, including newspapers:

> The following method of obtaining ice at any season of the year is said to be the invention of a chymist at Caen. Five pounds of pulverised sulphate of soda, and four pounds of sulphuric acid, at 36 degrees, to be mixed in a small cask (*Northampton Mercury*, cited in *The Times* 1826, spelling as in original).

23 Thévenot notes that references to refrigerating mixtures being used in fourth-century India were made in texts written by Ibn Abi Usaibia, a thirteenth-century physician and historian from Damascus (1979, p. 24).

Whether or not its principles were fully understood by its users, this technique was used to make frozen juices and iced drinks, which became popular among the wealthy, and there is evidence that mixtures of ice and sodium chloride were even used to freeze foods before mechanical refrigeration was available, indicating a degree of popular interest in manipulating temperature to achieve a refrigerating effect.

To trace the origins of making cold mechanically, we turn to Scotland in the mid 1700s, at that time a world centre for science and engineering second only to Paris. William Cullen's (1710-1790) work in chemistry was of great consequence in the journey towards the artificial production of cold for it was in his laboratory at the University of Glasgow that mechanical refrigeration was born. In the course of Cullen's research on the evaporation of fluids, he happened to notice that the evaporation of ethyl ether was accompanied by a significant drop in temperature and in 1755 he performed a highly important laboratory demonstration. He showed that by taking a liquid which boils at low temperature and rapidly reducing atmospheric pressure with a vacuum pump, the liquid would evaporate at temperatures below 0°C, absorbing heat from the remaining water and producing a small amount of ice (Cooper 1997, p. 25). In his essay *Of the Cold produced by evaporating Fluids*, he explained that:

> In an experiment made with nitrous ether when the head of the air was 43°F we set the vessel containing the ether in another vessel a little larger containing water. Upon [completion of this experiment] we found most of the water frozen and the vessel containing the ether surrounded with a thick and firm crust of ice (Cullen 1756).

Cullen's was the first apparatus for making ice mechanically. Although not able to produce ice on a large scale, the low temperatures that had been strategically exploited under natural conditions throughout history, could now be deliberately produced (Thévenot 1979, p. 21).

Three routes to mechanical cooling

Mechanical refrigeration developed along three principal routes and the precursors of each emerged in three different countries within a fertile period of twenty-five years. First was the 'vapour compression' system, which used the compression and evaporation of liquefied gases, developed in England in 1834 by Jacob Perkins. This was followed in 1844 by John Gorrie's 'cold air' system in the United States, which relied on expanding pre-compressed air. In 1859 in France, Ferdinand Carré developed a 'vapour absorption' system. Refrigerating machines can be divided into two main groups: those that remove heat from air by allowing it to expand while doing work, and those that remove heat from liquid by allowing it to evaporate. This second category can be subdivided into absorption and compression machines (Crawhall & Lentaigne 1934, p. 4). Of these, compression systems proved to be the most efficient thermodynamically and became the norm for domestic machines.

Jacob Perkins (1766-1849) was born in Newburyport, Massachusetts and emigrated to England in 1819. A prolific inventor with numerous patents for steam engines and boilers, he built on Cullen's work on the evaporation of ether by designing a compression machine using ethyl ether. He filed a British patent in 1834 for what he described in his patent specification as:

> an arrangement of apparatus or means … whereby I am enabled to use volatile fluids for the purpose of producing the cooling or freezing of fluids, and yet at the same time constantly condensing such volatile fluids and bringing them again and again into operation without waste (Thévenot 1979, p.40).

Perkins had developed a closed system whereby cooling was achieved through the repeated vaporisation and condensation of a refrigerant in a continuous cycle. Apparently, for a time, Perkins sold ice from a barge in the Thames, but Britons had not yet acquired the taste for iced drinks that their American counterparts had done and lack of interest on the part of his fellow Londoners made this a short-lived initiative (Shachtman 2000, p. 61). Unable to find financial backers for his machine, it never went into production. Nevertheless, Perkins' device is regarded as the parent of compression refrigerators; though there were earlier patents, his was the first working model to be built, and the first to bring together the four basic components of a fridge – a compressor, a condenser, an expansion valve and an evaporator. Contemporary refrigerators operate on exactly the same principles as Perkins' did and the most significant changes since then have been in the refrigerants used rather than in the design of the compression system.

Perkins may well have been influenced by an exchange of ideas with Oliver Evans (1755-1819) from Delaware. In his 1805 book, *The Abortion of the Young Steam Engineer's Guide*, Evans discussed how a steam engine could be used to extract latent heat from water to make ice and included a description of a closed cycle refrigeration system. Though Evans never built a working version, Perkins may have followed his description when constructing his own compressor. The two had become friends and collaborators when living in Philadelphia and Evans corresponded with both Perkins and Trevithick on the subject of steam engines. Whereas Perkins' invention was a vapour compression machine, what Trevithick had envisioned in his 1828 letter to Davies Giddy was an air machine, much like the one that John Gorrie (1803-1855) went on to develop.

Gorrie was a physician working in a hospital in Apalachicola, Florida, in the 1840s. Believing the high incidence of malaria and yellow fever among his patients to be caused by extreme heat and humidity, he attempted to find a way to cool the hospital wards. His solution was to suspend a basin of ice from the ceiling and rig up piping to draw fresh air over the ice and through the room. His system relied upon a constant supply of ice so, with ice supplies in the south being both expensive and unreliable, he set about building an ice-making machine of his own. Gorrie produced artificial ice using the principle that the rapid expansion of compressed air had a cooling effect. Air was compressed under high pressures in a chamber immersed in water. By releasing the pressure, the air was allowed to expand very quickly, absorbing heat from the water surrounding the chamber and creating temperatures low enough to freeze it. Thus, with air as his refrigerant, Gorrie developed the first 'expanding cold air' type of refrigerator.

In 1844, Gorrie gave up his medical practice to concentrate on perfecting his system and he took out American and British patents in 1849 and 1850. It was in the summer of 1850 that he put on a public demonstration of his machine at a social gathering. The previous winter in New England had been unusually mild so ice was in very short supply in the south that summer. Gorrie's colleague and collaborator, a Mr Rosan, made a wager with the party guests that, despite the shortages, they would still be able drink iced champagne that evening. Rosan won his bet. Gorrie's ice making machine was put to work and produced several pounds of ice while the party guests looked on, making it possible to disentangle the temperature of southern drinks in summer from the temperature of northern lakes and rivers the winter before (Shachtman 2000, p. 75).

Coverage of this event in the *New York Globe* reported that "there is a crank down in Apalachicola, Florida, that thinks he can make ice by his machine as good as God Almighty" (Woolrich 1967, p. 191). Woolrich highlights the controversial nature of this kind of research, noting that religious objections had periodically been raised about attempts to produce cold mechanically, and speculates that this might have been what motivated Gorrie to write under the pseudonym 'Jenner' in his numerous articles published in the *Apalachicola Commercial Adviser* on ice, cooling and disease (Woolrich 1967, p. 190). Nevertheless, by 1854 Gorrie was promoting the potential commercial application of mechanical refrigeration in his pamphlet, *Dr John Gorrie's Apparatus for the Artificial Production of Ice in Tropical Climates*. He suggested that his device:

> might enable the hardy mariner to better serve mankind, he who contributes so much to our wealth and pleasure by transporting us from shore to shore the rich production of the tropics – as animals and fruit, when divested of life, may be preserved entirely with all of their juices in a low temperature. This principle of producing and maintaining cold might be made instrumental in preserving organic matter an indefinite time and thus become accessory to the extension of commerce (Gorrie 1854).

A report of Gorrie's invention was published in the Proceedings of the Civil Engineers of Great Britain and gave it international recognition as the first commercially viable refrigeration machine. To his great disappointment, though, Gorrie was never able to find investors to allow him to take its development further (Thévenot 1979, p. 441).

Although the first in their respective fields, it was two decades or more before Perkins' or Gorrie's systems were pursued any further. Compression systems would eventually become the norm for domestic use, but this was by no means certain at the outset; instead, it was Ferdinand Carré's ammonia absorption system that initially dominated refrigeration applications. Carré was a very active inventor and had multiple patents in the 1850s and 1860s, some fifty of which were in the field of refrigeration. He recognised ammonia's potential as a refrigerant early on and built a 'continuous-acting absorption machine' comprising a generator, an absorber, a condenser and an evaporator. In his system, heat was applied to a chamber of ammonia and the gas that was driven off collected and condensed in a second chamber immersed in water. When the process was reversed and heat applied to the second chamber, the evaporation of ammonia had a refrigerating effect and a vessel of water placed within it would freeze. He patented his design in Britain in 1859, and in the United

States the following year, and his machines were taken up commercially soon after. Use of Carré machines spread relatively rapidly; they were imported to and manufactured in a range of countries and Thévenot (1979) argues that it was the first refrigeration machine that became important industrially.

INDUSTRIAL DRIVERS OF REFRIGERATION

Arguably, the three key forces driving the early period of artificial refrigeration were the manufacture of ice in the southern United States, the brewing industry in Germany and the northern United States and the emergence of a trade in shipping meat by sea, much of which centred around Britain and its trading networks with North and South America, Australia and New Zealand.

Manufacturing artificial ice

The first commercial plants for making ice were set up in the early 1850s in Australia and the United States. In the United States, Alexander Twining (1801-1884) had been working on a vapour compression refrigeration system and in 1857 published a booklet on the *Manufacture of Ice by Mechanical Means on a Commercial Scale (By steam and water power)*, but his choice of Cleveland as the location for his business proved to be a poor one and it struggled in the face of competition from plentiful supplies of natural ice from the Great Lakes. The plant folded after just a few years and plans to open a second plant in New Orleans were disrupted by the Civil War (1861-65). Perkins may never has got as far as expanding his refrigeration design into an ice plant, but James Harrison (1816-1893), a newspaper publisher turned engineer, used a similar ethyl ether compression machine to manufacture the first Australian ice in Geelong in 1851, as an alternative to natural ice imported from New England. The two main models of refrigerating systems used in the artificial ice industry were Harrison's compression system and Carré's absorption machine, both of which were shown at the International Exhibition in South Kensington in 1862 (Thévenot 1979, p. 38). The territorial division between the two machines was quite marked, with Britain and Australia adopting Harrison's model, and France and the United States favouring Carré's.

Harrison visited London for a period in 1856. While there, he patented his design, had contact with key scientific figures such as Faraday and collaborated with the firm Siebe & Co. to manufacture his machines. He had one shipped to Australia in 1859 and, after his return, Harrison formed a partnership to set up the Sydney Ice Company. The *Sydney Morning Herald* reported on the company's progress:

> The want of a regular supply of Ice having been so long felt by the inhabitants of Sydney and its vicinity, the Sydney Ice Company, now established, have the pleasure in announcing that they have in course of completion one of Harrison's ice-making machines … and that they will be in a position to commence the manufacture of ice upon an extensive scale, for the ensuing year (*Sydney Morning Herald*, October 13th, 1860).

In an update a couple of months later, the newspaper gave word that "a very interesting branch of industry – the manufacture of ice – has been within the last few days initiated in Sydney" (*Sydney Morning Herald*, Friday December 21st, 1860). In the next few years Sydney's ice-making capacity grew, raising question marks about the future of ice imports in Australia, as elsewhere:

> We learn that the artificial production of ice is in Europe fast superseding the collecting of ice from frozen ponds and rivers. The great advantage of the former arrangement is, that the ice can be produced in blocks of a convenient size, whereas when obtained in masses it has to be sawn and chopped, involving expense and waste. … As good ice can be produced in Sydney in sufficient quantities to meet the requirements of the community, it is not likely that any more cargoes of American ice will be imported (*Sydney Morning Herald*, November 14th, 1864).

In the southern United States supplies of natural ice were not always easily available and ice manufacture, initially for medical purposes, became a critical issue during the American Civil War (1861-1865) when ice shipments were stopped by the blockade. In 1863, a Carré machine was smuggled through the blockade to a military hospital in Augusta and around the same time an ice plant opened in San Antonio, using a second Carré machine brought from France via Mexico (Woolrich 1967, p. 45; Jones 1984, p. 154). Largely because of the opportunistic movement of these machines, Carré's machine was well positioned to become the model for refrigeration systems in the United States, and indeed absorption machines did meet with more success and have a longer history of use in the United States than elsewhere.

Jones considers 1868 to be a significant year for artificial ice production in the United States for this was when the Louisiana Ice Manufacturing Company opened what was then the world's largest ice plant in New Orleans and started undercutting the price of natural ice (1984, p.151). In 1869 there were only five ice factories in the United States, all located in the south, but the next two decades were a time of considerable growth in artificial ice production. By the late 1870s the number of plants had grown to 29 and to 170 ten years later (Thévenot 1979, p. 72). Competition between natural and manufactured ice was fierce. An artificial ice industry was much slower to develop in the northern states due to abundant natural ice, though an 'ice famine' created by mild winters between 1888 and 1890 gave a significant boost to manufacturers. In 1908, New York still used twice as much natural as artificial ice and it was not until 1915 that artificial ice overtook natural ice use across the United States (Thévenot 1979, p. 73). In Europe, ice-making progressed more slowly and manufacturing only reached significant levels after about 1890. The industry was also shaped by different industrial needs. In Britain, the bulk of artificial ice was used by the fishing industry, hence ice factories were set up in east coast ports like Grimsby from around 1900. In Germany and France, by contrast, early ice production was mainly for the brewing industry.

The brewing industry

Breweries were major ice consumers and became the earliest industrial users of mechanical refrigeration. Much of the innovation in refrigeration technology therefore arose in connection with this industry, particularly in Germany and the United States. The earliest British patents for refrigeration devices were also for brewing applications. Henry Tickell, a brewer from Whitechapel in London, filed a patent in 1801 for:

> an apparatus or refrigerator for more speedily and effectually cooling the worts, and other fermented, fermentable or other liquors … manufactured, made, or used by, or in the processes of brewers, distillers, vinegar-makers, sope-makers, sugar-refiners, [or] chemists (Collier 1803, p. 76).

In Tickell's design, wort, a malt-sugar solution, was cooled by passing it through pipes immersed in water, which provided a large surface area from which the heat could dissipate, whereas in Robert Salmon and William Worrell's 1819 patent for an "apparatus for cooling, condensing and ventilating worts" the cooling method involved blowing cold air (Woolrich 1967, p.149, 154).

By the 1860s, American breweries were consuming over a million dollars worth of ice per year (Shachtman 2000, p. 72). Growth in the industry, coupled with concerns about unpredictable ice supplies, prompted breweries to start investing in refrigeration machinery. The earliest mechanical installations came at the close of the 1850s, with a Harrison ether compressor machine in the Glasgow & Co. brewery in Bendigo, near Melbourne, and a prototype ethyl ether compressor designed by Ferdinand Carré installed in a brewery in Marseilles (Thévenot 1979, p. 77). Methyl ether compressors designed by Charles Tellier (1828-1913), a French engineer, were being installed in New Orleans and Marseilles by the late 1860s and Tellier also published an explanatory pamphlet in 1871 on the application of refrigeration for producing and storing beer (Thévenot 1979, p. 414).

In Germany, Carl von Linde (1842–1934), a former student of Rudolf Clausius, had stumbled into refrigeration quite by chance as a result of a competition to design a device for cooling paraffin. It struck him that refrigeration was still a vastly under-explored field and he put his energies into designing an ammonia based compression system which, again, found application first within the brewing industry. He had published work on refrigeration in a regional publication, the *Bavarian Industry and Trade Journal*, in 1870, but it was when he presented at an International Congress of Brewers in Vienna in 1873 that he attracted the attention of companies in Germany and Austria (Thévenot 1979, p. 414). Linde installed an experimental refrigeration system in Munich in 1873 and was then commissioned to design refrigeration units for a brewery in Trieste, Austria. He supplied a machine to the Heineken Brewery in Rotterdam in 1877, and to Carlsberg in Copenhagen the year after. At the end of the 1870s he gave up his professorship at the Technical University of Munich to work on refrigeration full time. Ice shortages from an unusually warm winter in 1883-4 boosted interest in his machines, both for brewing and also for meat processing and storage, which was rapidly becoming the second major market for refrigeration systems (Thévenot 1979, p. 77). Linde's first company outside of Germany was the Linde British Refrigeration Corporation, set up in 1885. His ammonia compression system proved to be more efficient than Carré's and his company sold thousands of machines throughout Europe for ice factories, cold stores and slaughter houses as well as breweries.

While German innovation in refrigeration was very oriented towards brewing, Britain had less motivation to follow suit. Important national differences in tastes for beer gave rise to different brewing methods. British ales were generally made using a 'top fermentation' method, for which the specific temperatures were not crucial, whereas German lagers relied on 'bottom fermentation,' which required a narrow temperature range between 47-55°F (Sigsworth 1965). The use of ice made it possible to extend the fermentation period through the summer, making year-round production possible. During the 1840s, high numbers of German immigrants arrived in the United States, bringing with them the practice of drinking lager. The widespread adoption of German lagers had an impact on American brewing as increased demand for lager beers triggered increased demand for refrigeration within the industry (Shachtman 2000, p. 72). By 1915, over 90% of American breweries had moved from ice to artificial refrigeration (Thévenot 1979, p. 415). Developments in refrigeration were therefore powerfully shaped by changing cultural practices, such as the movement of a particular migrant group and the importation of their consumption habits. Content with their warm beer, Britons were much more concerned about their meat.

Moving meat

Meat became a central concern in Britain's evolving refrigeration industry. Over time, a 'cold chain' was constructed linking abattoirs, ships, trains and trucks to cold stores, retail outlets and, eventually, domestic spaces. One strand of this story starts in Chicago in the 1870s where William Cronon describes the critical role played by Chicago's meat packers in:

> severing the natural relationship between death and decay. Their most basic technical innovation had been to devise new means for protecting meat … from its own perishability. To separate an animal's death from the decay that ordinarily followed hard upon it, they had harvested the winter's cold and suspended the wheel of the seasons. In the chilled factories by the stockyards, livestock died but did not rot. Their flesh could stay for days or weeks, long after the time it would otherwise have become inedible, in the well-iced branch stores that packers built throughout the nation (Cronon 1991, p. 248).

Refrigeration could hold meat in stasis while simultaneously making it more mobile. By keeping meat in a chilled suspended state and retarding its temporal passage into a state of decay, its spatial reach was profoundly amplified.

Ice and rails

Cronon describes the refrigerated railroad car as "a simple piece of technology with extraordinarily far-reaching implications" in his analysis of the role played by 'ice and rails' in the reshaping of Chicago and the American meat industry (1991, p. 234, 232). I am interested here in how refrigerated transport extended the reach of Chicago beef across the United States and even into Britain. Refrigerator cars were used to an extent in Europe but refrigerated rail transport was very much an American story, albeit one which had impacts well beyond for, through the intersecting journeys of trains and ships and ice and beef, London and Chicago became intimately connected.

A primary challenge facing those trading in meat was the process of decay that rapidly rendered dead flesh at first unappetising and then inedible. This brought tremendous pressure to either sell meat for immediate consumption or to preserve it without delay by methods such as salting, smoking, pickling or canning. In an industry powerfully shaped by natural cold, livestock tended to be butchered during early winter so as to take advantage of cold weather to help slow the degeneration of fresh meat. Capital investment in meat processing plants in the United States increased in the 1860s and 1870s after the Civil War. New divisions of labour and technologies of mass production were introduced to create a mechanised 'disassembly line' (Cronon 1991, p. 229). However, in an industry that traditionally operated only part of the year, many were troubled to see this investment being underutilized in the summer months. And so it was that Chicago's meat packers searched for a way to break with the economic inefficiencies of natural seasonality:

> [they] began to consider ways of manipulating the seasons of the year. If only winter temperatures could somehow be stored for use during the hot Illinois summers, expensive capital plant need not sit idle. The railroads provided the means for performing this improbable feat (Cronon 1991, p. 231).

Ice was to become a crucial tool in the meat-packing industry, one that permitted companies to slaughter and pack year-round. Some ice was harvested in the Chicago area in the 1840s and 50s but local supplies were limited and consumed mainly by the brewing industry. Perhaps ironically, the expansion of meat processing in Chicago, the very expansion that was facilitated by increased use of ice, was itself largely responsible for increased pollution of local water supplies, and thus of local ice. American ice had been traded internationally since the early part of the century but the logistics of shipping it by water versus land made it easier to supply Calcutta than Chicago. As a bulky, highly perishable and relative low value commodity, it was not viable to transport ice far over land, at least not until the arrival of the railways. Railroads played a major role in American westward expansion and economic construction, their construction accelerating from the mid 1850s and through the 1860s (Thévenot 1979, p.113). The railroads gave Chicago access to cleaner and more plentiful supplies of ice from Wisconsin and, by making livestock, ice and meat more mobile, helped transform Chicago's position in the meat trade.

Although the focus often tends to fall on meat, fruit and dairy products were also important cargoes sent by rail, indeed the earliest patents for refrigerated rail cars were for chilling fruit. Key developments in refrigerated transport were initiated by both meat-packers in the mid-west and fruit farmers on the west coast as a way to break into lucrative markets in the East, a week or more away by rail. Attempts were made to ship butter, fruit and seafood by rail in the early 1840s using blocks of natural ice and crude insulation: the first lobsters to reach Chicago from Maine aroused great excitement in 1842; chilled butter was successfully sent from New York to Boston in 1851; and, in 1866, Illinois farmer Parker Earle packed strawberries in ice-cooled chests to keep them fresh during the 300 mile journey to Chicago (Cummings 1940; Anderson 1954, p. 47; Kitchen 1949, p. 325). An 1857 article in *Scientific American* described meat and poultry being shipped east from Chicago in "a new description of rail car, fitted up on the principle of a refrigerator" and cooled with blocks of ice (1857, p. 70). The technology was still fairly limited and the results mixed but experimentation in the 1860s examined how air circulated inside railcars, evaluated the best place to position ice for optimum cooling and tested various salt-ice mixtures.[24]

George Hammond (1838–1886) a butcher and meat packer in Detroit was one of the first to send meat by rail. He began transporting chilled beef from Detroit to Boston in 1869 using an iced railcar originally designed for shipping fruit. Shrewdly setting up his operation next to ice harvesting plant, his venture grew into a highly profitable shipping business (Cronon 1991, p. 49 & 233). This close association between beef and ice was also key for Thomas Rankin (1839-1915). Rankin had worked at the Louisiana Ice Works in New Orleans in the late 1860s and had patents for various refrigeration applications, including breweries, ships, ice rinks, cold storage plants and railcars. Working on the principle of establishing a 'cold chain,' he linked refrigerated abattoirs in Texas to east coast markets via a refrigerated rail service. The Texas and Atlantic Refrigeration Company of Denison began carrying chilled beef cross country to New York, as reported in the *Galveston Daily News* on 12 December 1873:

> we rejoice at the success of the experiment of shipping of fresh beef in refrigerated cars from Texas to New York. The telegraph reports that the meat arrived in good order and sold readily. … Ninety-nine cars are to be built immediately for the purpose of extending the operations … and three trains a week are to be run (Woolrich 1967, p. 111).

More than anyone, though, it was Gustavus Swift (1839-1903), head of a Chicago packing-house in the 1870s, who is credited with making refrigerated rail transport for fresh meat commercially viable. The potential for tapping new markets on the eastern seaboard seemed evident to him, but he was unable to generate interest from rail companies in developing refrigerated cars. Swift therefore took it upon himself to build a suitable insulated ice-cooled car. He adopted a system designed by Andrew Chase and the Swift-Chase car was put into service in 1879. In order to resupply his railcars as ice melted on the long journey east, Swift also set up a chain of icing stations, each with its own icehouse and harvesting operation (Cronon 1991, p. 235). Other packers followed suit, developing their own refrigerator cars and ice-cutting outfits.

24 The most common methods were slatted bunkers containing ice blocks to cool air as it circulated, or open bins filled with crushed ice and salt, either on the floor or suspended from the ceiling.

Rail companies' disinclination to pursue refrigeration technology was partly explained by the fact that many of the companies were heavily invested in stockyards around the country and found it was more profitable to carry livestock than dressed meat. Unsurprisingly, there was opposition from other players in the meat trade, from the butchers, slaughter houses and feeding stations whose businesses were threatened by the easterly encroachment of mid-west meat. Consumers also had to overcome deep-seated suspicions about refrigerated meat. They were, quite sensibly, wary of buying meat of unknown provenance from animals that had not been freshly slaughtered and which had been carried great distances across the country. To people for whom the norm was to buy locally and fresh, this appeared a risky proposition. However, the introduction of refrigeration disrupted the logic upon which their reasoning was based. Time since slaughter was no longer necessarily a helpful measure of freshness since dressed meat that was kept refrigerated could be equally 'fresh' to that newly killed. It took some time for people to grow comfortable with the idea of refrigerated meat but low prices seemed to be the best way to overcome consumers' hesitation. Transporting dressed meat proved much more economical than sending livestock for slaughter close to market because it eliminated the freight costs on the portion of each animal, up to 45% claims Cronon, that was ultimately thrown away as waste (1991, p. 236). This made it possible for packing firms to undercut the price of freshly slaughtered meat. Having an extensive network also enabled them to use the strategy, where necessary, of selling below cost in order to build up their market share (1991, p. 243). Opposition eventually collapsed, unable to compete with the packers' aggressive pricing of dressed meat.

The packers had become a powerful force. Within a decade they had extended the reach of Chicago beef and profoundly reshaped the geographies of meat in the United States and beyond. Refrigeration helped them smooth the curves in the annual pattern of slaughter, allowing it to take place at some remove, both spatially and temporally, from the point of sale. Dressed meat became more mobile; Cronon describes animals' lives being 'redistributed' as they were born in one place, fattened in another, killed in another and consumed in yet another (1991, p. 224). Once a localised and distributed business, slaughter became centralised in the Midwest. By reorganizing the industry, setting up their own freight organizations, and achieving cooling-on-the-move, packers built the capital and capacity to distribute their products nationally. In this way, western packers found a way to dominate eastern markets.

Spatially, the effect was to bring the coasts closer together, at least in relative terms. Parallel developments in refrigerated shipping also resulted in time-space compression on an intercontinental scale. Midwest meat moved east, then further east again across the Atlantic to Britain. As Cronon puts it, “dressed beef brought the entire nation – and Great Britain as well – into Chicago’s hinterland” (1991, p. 238).

Ocean-going vehicles of cold[25]

Advances in engineering and the development of steamship technology facilitated the movement of meat into and within Britain. Carcasses were brought by rail and sea from Scottish farms to London’s markets and some cattle were imported from Ireland and continental Europe by steamship, along with small quantities of fresh meat in the winter months (Perren 1978, p. 72). High duties had been a disincentive to the import trade until Prime Minister Robert Peel’s 1842 Free Trade budget abolished many trade restrictions and eased the entry of foreign livestock and meat into Britain. Poor harvests in the 1840s saw the decade christened as ‘the hungry forties’ and concern began to circulate about whether the country’s food supplies were adequate to feed its growing population. The nineteenth century was a time of rapid industrialisation, urbanisation and population growth. The movement of meat became an issue of heightened importance and Britain looked elsewhere, particularly to its colonies, for food. Growth in population in the mid 1800s, and an accompanying rise in meat consumption per capita, prompted the Society of Arts to turn its attention to the problem. In 1863 the Society offered a medal and a prize of £100 for a practical invention that would enable fresh meat to be brought from overseas and, in 1866, a committee was appointed to investigate ways to improve the country’s food supply (MAF 1925, p. 8). The worry, as expressed by the Chairman, Harry Chester, in the Society’s journal, was that “the home supply of meat for the population of these islands is not nearly sufficient for the due sustenance of one half of the population” (Chester 1867, p. 100).

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25 In his 1884 patent, Raydt describes carbon dioxide as “a much more intense vehicle of cold than the gases heretofore used” (Pearson 2005, p. 1144). I borrow Raydt’s expression here to allude both ships as vehicles for transporting cold and also to the refrigerants that made possible these voyages.

The spectre of so many potentially hungry mouths gave impetus to both philanthropic initiatives and business ventures. The 1860s and 70s were a period of innovation and experimentation as attempts were made to meet the challenge of transporting meat across great distances.[26] As British farmers struggled to meet domestic demand, there was a parallel development of import trades in both livestock and dressed meat. Nelson Morris initiated the transatlantic shipment of live cattle from the United States to Glasgow and London in 1868 (MAF 1925, p. 7). Though slow to grow initially, it became a busy trading route during the next decade, at which point imports from Europe were replaced by those from the United States and Canada (Zimmerman 1962). International transportation of dressed meat built upon successful water shipments over shorter distances in the US. In 1868 the race began between Henry Howard (1829-1913) and Thaddeus Lowe (1832-1913) to be the first to send chilled beef by ship from Indianola, Texas, around the coast to New Orleans. Howard had been involved in transporting Boston lake ice inland to San Antonio from the port at Indianola. Struck by the high cost of imported ice, which sold for around ten cents per pound, relative to prime beef which, due to its ubiquity, sold at just two cents a pound, he wanted to find a way to transport it to areas of higher demand where it could be sold more profitably (Woolrich 1967). Meanwhile, Lowe's route into refrigerated shipping came via military research on applications of carbon dioxide and in 1867 he designed a carbon dioxide compression refrigeration system to be installed aboard a ship. The competition between Lowe's *William Tabor* and Howard's *Agnes* was keenly promoted by hotels and restaurants in New Orleans (Woolrich 1967, p. 53). The *Agnes* arrived first and the New Orleans *Daily Picayune* (13 July 1869) described the banquet of Howard's beef served at the St Charles Hotel to celebrate his success (Woolrich 1967, p. 104). Believed to be the first successful shipment of fresh meat by sea, the two had showed that sufficiently low temperatures could be maintained on board to enable beef to be shipped safely.

By this time, attention had already turned to making transatlantic crossings with cargoes of fresh meat. After Ireland, the closest country to Britain with a significant meat surplus was the United States. The traffic in refrigerated meat built upon pre-existing trade networks with the United States. When the Civil War disrupted Chicago packing companies' access to markets

26 Perren (1978, p. 82) notes the increase in the number of patents for mechanical refrigeration applications rose from 11 in the 1850s to 30 in the 1860s and 56 in just the first half of the 1870s.

in the southern states in the 1860s, Liverpool and London had become valuable markets for surplus pork products, exported in the form of bacon and barrels of pickled or salted pork (Perren 1978, p. 71).[27] As early experiments made clear, shipping fresh meat from America to Britain without refrigeration was not a viable solution (Anderson 1953, p. 60). However, from shipping ice to Britain it was a logical next step to try sending cargoes of meat cooled by natural ice and, in October 1875, this was Timothy Eastman's approach when he sent a cargo of beef by steamship from New York, chilled with natural ice in bunkers in an insulated hold (Critchell & Raymond 1912, p. 26, 190). Eastman's shipment marked the start of the refrigerated trade in meat to Britain. The modest traffic in unrefrigerated meat from Europe prior to that time had been exclusively a winter-time activity (Perren 1978, p. 128); now, for the first time, sending meat was not dependent on the weather. The Select Committee on Livestock Import noted in an 1877 report:

> with regard to the importation of dead meat from America … the evidence shows that there are hardly any limits to the amount of meat which can be imported from that country; that in cool weather the meat can without difficulty be delivered here in perfect order, and that with greater care in the packing, and with better arrangement for storage here, it could be brought over in the hottest months (Report from the Select Committee on Cattle Plague and Importation of Livestock (1877) IX, p. viii, cited in Perren 1978, p. 127).

Scope for expanding the trade was evident when, within two years, eight companies were carrying chilled beef across the Atlantic, compared to four who carried cattle (Perren 1971, p. 432). Most shipments left from New York, and a few from Philadelphia and Boston, headed primarily for London or for Liverpool. By 1885, twenty five steamships regularly ran this route and all the steamship lines between the United States and Britain had been adapted to carry chilled beef, some with ice bunkers and fans to circulate cold air, others by pumping chilled brine through pipes running between the sides of beef hanging in the hold (Anderson 1953, p. 61; Thévenot 1979, p. 79). Though certainly an important step, the Atlantic crossing was a relatively short and straightforward voyage; the real challenge would lie in crossing the equator.

Many had wondered whether there was a way to reconcile the imbalance between meat surpluses in Australia, New Zealand and South America with growing demand in Europe. In

27 Small amounts of pickled beef had been exported in 1840s, though this did not prove particularly popular and consumption was limited mainly to the Navy (Cronon 1991, p. 225).

the mid 1800s, Australia and New Zealand traded mostly in wool and gold. Sheep were reared for wool, tallow and hides, leaving the meat as little more than a by-product that was often simply discarded (MAF 1925, p. 8). Much of the innovation that ultimately made this meat trade possible came about in Australia, thanks to three Australian immigrants, James Harrison, originally from Scotland, Thomas Mort (1816-1878), a wool merchant from England, and Eugène Nicolle (1823-1909), a mechanical engineer from France. Recognising the ready markets overseas in Europe, and the profits to be had by feeding Britain, they turned their energies to finding a way to export Australia's surplus meat. Canning factories had exported some meat but this had not been sufficiently popular to develop into a major industry. What Britons wanted was fresh meat. Here, geography presented some challenges. Australia's physical location left it isolated from other major markets. Tests had shown that at temperatures at or above 0°C meat would last a maximum of three weeks (Woolrich 1967, p. 52). Even with the fastest ships, Australia lay a minimum of one month's sailing time from European markets. Without some means of artificial cooling, the voyage across the equator was just too hot and long.

By 1860 Nicolle had started working on constructing an ice making machine, based on the compression system Harrison had designed and, with co-investors, purchased Harrison's Sydney Ice Company in 1861. Mort, meanwhile, had diversified his business into dairy products, due to falling wool prices, and was exploring refrigeration as a way to give these products better access to markets within Australia. In the mid 1860s, the two began collaborating on the idea of developing refrigeration technology to freeze and export Australia's meat to Britain. Mort provided financial backing for Nicolle's research as he designed an ammonia compression system:

> Mr Mort offered to find the capital if I contributed the skill. I therefore designed a special machine able to store and freeze some 40 tons of meat. … This apparatus was designed to suit ship board, and it was in connection with this that we met our first rebuff. … Exception was also taken to the circulation of ammoniacal gas at high pressure, which might in heavy weather escape, and perhaps damage the rest of the cargo (cited in Organ & Turnidge 2006).

Their first negotiations to install a refrigeration system aboard a ship were not fruitful. Unable to find a ship captain willing to carry ammonia-based equipment, or an insurer willing to underwrite such a voyage, they were forced to redesign their system based upon a cold air method instead. Mort organised a public meeting at the Sydney Chamber of Commerce in February 1868 to promote their meat exporting scheme. He managed to recruit investors and a Meat Export Committee was duly set up. Soon after, Mort learned that a first attempt to make a voyage carrying refrigerated meat was already underway.

In France, Charles Tellier had developed a methyl ether compressor in 1863 and by 1868 he had installed refrigerating systems in breweries in New Orleans and Marseilles, as well as in a chocolate factory (Thévenot 1979, p. 102). Convinced that his system could usefully be applied to preserving meat, Tellier tested its preservation properties in a factory near Paris before initiating the race to ship meat to another continent in early 1869. He attempted to send a cargo of meat from Montevideo, Uruguay, to London aboard the *City of Rio de Janeiro* but his attempt failed when the methyl ether compressor broke down. Although it was to be nearly a decade before such a voyage was successfully completed, this shows that mechanised marine refrigeration was already being attempted by the time Eastman's 1875 cargoes of beef were being cooled with natural ice on route from New York to Britain.

For a time Mort's focus was on constructing a refrigerated slaughter house and freezing works to Nicolle's design in Lithgow, a hundred miles from Sydney, so that livestock could be brought from Western Australia, slaughtered and refrigerated for onward transport (Organ 2006; Thévenot 1979, p. 79). The story goes that in 1875, to promote his refrigeration business and demonstrate the edibility of frozen food, Mort hosted a picnic for three hundred guests and served them food he later revealed had been frozen at his plant for over eighteen months.[28] Harrison too had turned his attention from producing ice to developing a system for shipping frozen meat. He was awarded a gold medal at the 1873 Melbourne Exhibition for his design and later that year he put it into practice by sending beef and mutton from Melbourne to London aboard the *SS Norfolk*. However, a fault in the cooling system allowed his cargo to thaw prematurely, leaving him with unsaleable meat and huge financial losses (Thévenot 1979, p.81, 442; Woolrich 1967, p. 55). Three years later it was Mort and Nicolle's turn to attempt a shipment to Britain in the *SS Northam*, only to experience an equipment failure themselves when the refrigerating machinery broke down before the ship left port. Unable to

28 According to Lithgow Tourism, http://www.lithgow-tourism.com/tmort.htm

delay the departure, and left with insufficient time to repair the problem and reload, the ship sailed without Mort and Nicolle's cargo and marked the end of their efforts to export meat.

Around the same time in France, Tellier was equipping his steamship, *Le Frigorifique* (which translates as 'The Refrigerator'), with methyl ether compression machines and in 1877 carried a cargo from Buenos Aires to Rouen. Tellier's was technically the first international shipment of meat using artificial refrigeration. His 'dry cold' system did preserve the meat during the three months crossing, but at a cost. The surface of the meat dried to form a protective 'crust' but its condition on arrival was poor, having suffered considerable weight loss from dehydration (Thévenot 1979, p. 80). Although not a complete success, and not yet economic, Tellier's shipment was a key step in the development of intercontinental meat transport. Despite their series of failures and false starts, much of the foundation of an intercontinental meat trade was laid by the innovation and persistence of Harrison, Mort and Nicolle in Australia and Tellier in France.

It was in 1878 that the French accomplished a fully successful shipment of mechanically refrigerated meat across the equator (Thévenot 1979, p. 81). The *Paraguay* set sail from Marseilles and returned from Buenos Aires to Le Havre. Its cargo of 5500 mutton carcasses was preserved using Ferdinand Carré's equipment and arrived in excellent condition after their fifty day voyage from Argentina (Woolrich 1967, p. 55, 164). Meanwhile, brothers Henry and James Bell (1848-1931 & 1850-1929), who ran a chain of butcher shops in Glasgow and acted as the British agents for Eastman & Co., were seeking a better way of shipping their supplies of chilled beef from New York. The Bells viewed the current method of carrying beef amongst blocks of ice somewhat inefficient, since ice could occupy as much as a quarter of the hold (Woolrich 1967, p. 41). Kelvin put them in contact with James Coleman (1838-1888) and the three collaborated in setting up the Bell-Coleman Mechanical Refrigerating Company. Building upon the principles of Gorrie's cold air machine, and Kelvin's design improvements, they patented the Bell-Coleman dense-air machine in 1877 (Woolrich 1967, p. 136). They tested the system thoroughly on land before attempting an ocean crossing and, once confident that it could keep meat chilled effectively, installed it in the *Circassia* in 1879 to bring the first mechanically chilled beef from New York to London (Cooper 1997, p. 45; Miller 1985, p. 61). The *Strathleven* was also equipped with a Bell-Coleman machine. Loading in Sydney and

Melbourne in late 1879, the first cargo of mutton, beef and butter from Australia arrived in good condition in London in February 1880 after a voyage of 13,000 miles and nearly nine weeks at sea (Thévenot 1979, p. 81-2; Miller 1985, p. 61).

New Zealand's export trade in lamb and mutton began two years after the *Strathleven's* voyage when William Davidson, manager of the New Zealand and Australian Land Company in Edinburgh, and Thomas Brydone, the company's superintendent in New Zealand, chartered the *Dunedin* and fitted it with a Bell-Coleman refrigerating system. A system failure before leaving port meant that the first cargo had to be sold while still in New Zealand, but once reloaded the ship set sail for London. After ninety eight days at sea the meat was found to be of excellent quality and sold well at John Swan's stall in London's Smithfield market (Cooper 1997, p. 130). Davidson and Brydone's efforts won them the prize offered by the government for the first cargo of saleable meat to reach Britain and their success encouraged other companies to follow their lead and join the frozen meat trade.[29] Thomas Borthwick (1835-1912), a meat wholesaler and distributor, was quick to recognise the potential of this import trade. He became the selling agent for the New Zealand Loan and Mercantile Agency Co. Ltd. and a leading figure promoting the supply of imported frozen meat to Britain (Capie 2004). He opened meat depots in Liverpool, Manchester, Glasgow, and Birmingham and was responsible for introducing frozen New Zealand lamb and mutton to consumers in Liverpool and Manchester in 1883, before transferring to London in the early 1890s and taking over a stall at Smithfield Market (Perren 1978, p. 179). The sources of Britain's meat supply and its temporal pattern of consumption were both altered by this trade. Lamb, in particular, ceased to be a seasonal product and was now consumed year round. Alluding to some of the effects of the globalisation of trade, the Ministry of Agriculture and Fisheries made the observation that:

> the price obtained for a steer in the country districts of England and Wales is necessarily affected by conditions ruling in the distant Argentine; similarly, English lamb prices are influenced by conditions in, say, New Zealand. … As markets become worldwide, knowledge confined to one country, or one part of a country, is not, of itself, a sufficient guide for intelligent production and marketing (MAF 1925, p. vi).

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29 Davidson and Brydone received an award from the Institution of Professional Engineers New Zealand "for their foresightedness and dedication in taking the new technology of refrigeration and making it sufficiently reliable and efficient to enable New Zealand to develop an industry based on the export of frozen foods to the markets of the Northern Hemisphere" (Whitteker 2002).

In 1882, the *New Zealand Herald* also remarked on the changing notions of proximity which emerged from this trade, suggesting that:

> the exportation of frozen meat makes the colony of New Zealand as much a province of England, as easy a source of supply for the London market, as Yorkshire or Devon.

Together, these innovations in refrigerated shipping proved that British dinner tables could indeed be supplied with meat from as far afield as South America, Australia and New Zealand and that the intercontinental transport of perishable foods was commercially viable. If the question had been how to get meat from A to B, it seems refrigeration was the answer. Refrigeration reconfigured trade between Britain and her colonies, reshaping the economies of each. In the case of New Zealand, Belich describes refrigeration technology as "the knight in icy armour that rode to the rescue of the New Zealand economy in the 1880s," for, as Elliot put it, "the whole of this great industry, and to a very great extent the general prosperity and advancement of New Zealand, hangs on the slender piston rod of a refrigerating machine" (Belich 2002, p. 11; Elliot 1918, p. 87).

Remapping Britain's meat supplies

After the success of the *Strathleven*, cold air machines dominated shipping during the 1880s, before being superseded by more efficient carbon dioxide compression systems and then ammonia compression. Lloyds Register indicates that of the 460 refrigerated ships in service worldwide in 1902, half were British and Thévenot estimates that more than three quarters of all marine refrigeration machinery in use was British made (1979, p. 112, 177). Britain's leading role in marine applications is a reflection of its growing reliance upon food imports; the United States, in contrast, was much slower to develop a refrigerated fleet.

Before 1850, meat imports to Britain had been negligible but between 1850 and 1870 combined imports of live and dead meat increased by 197% (Perren 1978, p. 69). Although this represented just a small proportion of Britain's total supply at the time, it shows that meat from overseas was starting to become a significant part of domestic consumption by the 1870s. Around half of the cattle and a quarter of the sheep sold in London markets in the 1860s came from outside Britain, and the peak in livestock imports came in 1864, the year before a herd of Russian cattle arrived in Hull, bringing with them cattle plague (Raymond & Critchell 1912, p. 404). The 1865-6 plague outbreak led to a mass slaughter of British cattle and, not surprisingly, increased wariness about live imports. As the Commissioners conducting the inquiry into the outbreak stressed:

> it is essential that the re-introduction of the disease from abroad be guarded against. In our Second Report we recommended to Your Majesty that foreign cattle should be slaughtered at the port of disembarkation …. We believe that … the trade in foreign cattle, which has grown of late years to such vast proportions, should be subjected to proper regulations (Third Report of the Commissioners appointed to inquire into the Origin and Nature of the Cattle Plague, 1866).

The rapid growth in imports of meat on the hoof to which the Commissioners referred was clearly not without its dangers. Although a blanket ban on the movement of live cattle was not imposed, the 1869 Contagious Diseases (Animals) Act did place restrictions on cattle imports from certain European countries in order to safeguard domestic herds. This did three things. First, the ruling that cattle from particular places had to be slaughtered upon arrival meant that imports were channelled into those ports equipped with abattoir and cold storage facilities, and those without declined; in addition, traders had to start developing the means to distribute dead meat, now that they were no longer able to rely on taking animals directly to the point of sale for slaughter (Perren 1978, p.161). Secondly, it gave room for livestock imports from beyond Europe, hence by the 1890s two thirds of cattle shipped to Britain were coming from Chicago (Perren 1971, p. 437). Thirdly, the ruling helped facilitate the import of refrigerated meat and its timing proved fortuitous for exporters who soon after started sending chilled beef to London from New York.

North America became Britain's major overseas meat source during the 1870s, supplying four out of every five carcasses that reached Britain from beyond Europe, and the shift in focus from Europe to North America helped Liverpool flourish over east coast ports because its location on England's west coast left the port well positioned for transatlantic cargoes (Perren 1978, p. 123-4). United States exports were dominated by the same packing firms – Armour, Swift, Morris and the National Packing Co. – that had driven innovation in Chicago's stockyards and grown to dominate its domestic trade, but the influence of these powerful concerns was not restricted to the United States:

> Just as circumstances had favoured the extension of these firms' control over the American domestic market, they also allowed them to gain a large measure of control over the exporting businesses, with a system of subsidiary companies in Great Britain, which reflected the policies of the parent companies in the United States (Perren 1971, p. 441).

Riding on the increased reach of refrigerated meat, the companies were able to exert influence over the meat trade within Britain by expanding into the wholesale business and acquiring stalls in London's Smithfield Market. By the turn of the century, though, American beef exports were waning and had virtually ceased by the outbreak of the First World War.[30] A growing American population, coupled with rising incomes, led to increased domestic meat demand and limited surplus for export. By the last decade of the nineteenth century, Britain was turning instead to South America, particularly Argentina, for beef and to Australia and New Zealand for mutton and lamb.

The South American trade had also benefited from fears of disease from European animals following the cattle plague. Britain's Argentinean Consul-General noted that:

> at a time when the ravages of a widely extended disease have proved so fatal to the cattle of Europe … the feasibility of utilising the superabundance of meat produced in the rich pasture lands watered by the River Plate and its tributaries has become the subject of the greatest importance and one to which, within the last two years, the attention of scientific men has been directed (British Consul-General in the Argentine, Accounts and Papers, 1866, lxxi, cited by Jones 1929, p. 159)

Regular imports of frozen meat from Argentina were initiated in 1883 by The Plate River Fresh Meat Co., a company set up in London the previous year by English businessman George Drabble (Jones 1929, p. 162-6). Sansinena, an Argentinean firm previously involved in exporting tinned meat, expanded into frozen meat soon after, followed by Nelson & Sons, a second British firm, the following year. This meant that, in these early years, two thirds of Buenos Aires' frozen exports were in the hands of British firms (Perren 1978 p. 183-4, 207). Initially this trade was small and Argentinean imports continued to arrive primarily on the hoof. However, an outbreak of Foot and Mouth Disease led to Argentinean livestock shipments being embargoed (Jones 1929, p. 162). The alternative to landing live cattle in Britain was obviously to send meat chilled or frozen, which gave an important boost to the refrigerated meat trade. The growing profitability of this trade prompted what Jones terms an

30 The monthly livestock trade reports in the Journal of the Board of Agriculture stopped quoting North American beef prices with effect from 1913 (Perren 1978, p. 164).

‘invasion’ of the major American meat companies with their often cut-throat methods; Swift bought out an Argentinean cold storage company in 1907 and Armour and Morris entered the market the following year (Jones 1929, p. 163, 168). So, those same companies that had established the trade in American beef now diversified into South America and gained a high degree of control over exports of South American chilled meat to Britain (MAF 1925, p. 4). Perren notes that just before First World War, 20% of all beef consumed in Britain originated in South America and the major companies from the United States operating in South America controlled half of British beef imports (Perren 1978, p. 215). Again, with market stalls and wholesale depots in the larger cities, and travelling salesmen covering other regions, “it can therefore be said that these great South American organisations penetrate into every part of the country” (MAF 1925, p. 33).

The source of Britain’s meat supplies had therefore swung from Europe to North America and then to South America, Australia and New Zealand. The form in which most meat arrived also switched from live to dead. Until the late 1860s, more than half of meat imports took the form of livestock on the hoof and the remainder was mostly preserved meat such as bacon or salt pork. By the 1880s, nearly three quarters was dead and the majority of that refrigerated (Perren 1978, p. 123). In 1900, Britain imported 360,000 tons of refrigerated meat, two thirds of which arrived from Argentina, followed by New Zealand and Australia. In the next decade, the annual total more than doubled to 760,000 tons and by the time the Science Museum mounted its exhibition in 1934, import figures were around one million tons of meat, as well as significant amounts of refrigerated dairy products and fruit.

So, thousands of tons of chilled and frozen foodstuffs arrived on Britain’s shores each year, having been variously processed in refrigerated factories, transported by refrigerated trains, stored in refrigerated warehouses and carried from distant ports by refrigerated ships. The technology was in place to make things cold and keep them cold in transit, but what happened to this perishable food when it arrived? The cold chain tended to unravel when these goods reached Britain, often terminating abruptly at the port of entry because the availability of refrigerated transport and storage was so limited. The next challenge was therefore to maintain the low temperature of goods after they arrived, first in large commercial cold stores and eventually by extending the cold chain directly into people’s homes.

Cold reservoirs

Cold storage facilities were minimal in the early years of the refrigerated meat trade, making it essential to sell meat with some haste upon its arrival. It was a gamble to send meat to market in bulk, even for domestic producers, because of this lack of cold storage; "only the persons in the imported meat business who were geared to handling bulk consignments possessed coldstores," emphasises Perren (1978, p. 146). The first English cold store had been set up in Southampton in 1874, cooled by natural ice from Norway, but as imports grew through the 1880s and 1890s, and as foreign meat was increasingly distributed dressed instead of on the hoof, the creation of cold storage space became more critical. The cold storage industry developed hand in hand with marine refrigeration. Stores were initially set up by the dock companies themselves, close to where shipments were landed in the key ports of London and Liverpool. A store at St. Katherine's Docks in London opened in 1882 with room for 500 frozen mutton carcasses and its capacity expanded to accommodate 59,000 in just four years (Perren 1978, p. 177). With limited suitable space, the West India Docks Company improvised by fitting out two floating hulks as refrigerated stores (Critchell & Raymond 1912, p. 164-6). Tellerman's Fresh and Preserved Meat Agency set up a store in 1878 for chilled North American beef, Nelson & Sons opened a store under London's Cannon Street Station in 1885 to house lamb arriving from New Zealand and market traders eventually got access to refrigerated storage space under Smithfield Market itself (Perren 1978, p. 130, 178, 117). The ability to hold perishables in a refrigerated state made it easier for importers to handle bulk arrivals, helped them safeguard their investment and reduced the urgency to sell meat on immediately. Cold stores create a holding space or "reservoir into which supplies can be conveniently diverted during times of excess and from which they may be withdrawn during times of shortage," giving traders a way to balance supply with demand (MAF 1925, p. v).

Chilled meat was generally of higher quality than frozen and could be retailed at a premium, which provided the incentive to devise a way to ship meat chilled, not frozen, from South America, New Zealand and Australia. This was in the days before 'fast freezing' when the freezing process had a discernible impact on meat's taste and appearance, making it less moist and more discoloured than its chilled alternative. However, frozen meat was much more resilient than chilled. Carcasses could be stacked high during transit, rather than having to be handled with care and individually hung as was the case with chilled. While frozen meat could be stored for many months without diminishing in quality, the chilled product had a shelf life of around five weeks at most. Allowing for processing, loading and travel time, it had to be sold promptly within a week or two of landing. Its higher profitability was therefore balanced against a narrower window of time in which to make a sale; it is "the element of perishableness, coupled with the regularity of arrivals, which makes the business of selling chilled beef so dangerous," for there was always a risk that a glut of shipments might unexpectedly arrive at once, saturate the market and jeopardise profits (MAF 1925). The distance covered by the two forms once in Britain also differed, with chilled meat having a smaller reach than frozen. Anywhere more than a few hours by rail from the port would generally be supplied with frozen meat not chilled as rail transport usually relied on railcars that were insulated or ventilated rather than iced or mechanically cooled (MAF 1925, p. 34).

The number of cold stores grew slowly and by the late 1880s London boasted only eight. Together they had capacity for just over one fifth of frozen meat imports and one tenth of incoming refrigerated cargoes, so clearly the majority of meat imports went directly onto the market rather than into storage (Perren 1978, p. 179). Private companies and local authorities gradually opened stores in the larger cities and, over time, in provincial towns. Demand also grew for refrigerated storage for products like butter and fruit, along with more unusual items such as flower bulbs and furs. By the 1890s, cold storage started to take shape as a new industry and the Cold Storage & Ice Association was formed in 1899 to foster its development. By 1912, London's storage capacity was sufficient to accommodate three million mutton carcasses, with Liverpool having space for two million and Glasgow and Southampton each a little over half a million, but it was only with the expansion of cold storage to meet war needs during World War One that sufficient capacity was added to meet demand (Rixson 2000, p. 332). The business of making things cold and keeping them cold had proved to be a lucrative one.

GRASPING COLD: PHYSICS IN THE MUSEUM AND THE KITCHEN

The 1934 Science Museum exhibition covered the main industrial applications of refrigeration but paid particular attention to refrigerated transport and food storage, showing people where their food came from and how it reached them. Visitors vicariously travelled from breweries, dairies and bacon factories to cold stores, ice cream factories and skating rinks, picking up insights into the gas storage of fruit and the secrets of lard and margarine manufacture along the way. A series of working models were on display, along with three-dimensional cross sections of a refrigerated ship and rail car. The message was clear that with refrigeration technology the reach of fresh food had grown exponentially. Though the term would not be coined until decades later, the notion of an increase in 'food miles' was implicit in the exhibition. In the 1830s, a century before the exhibition, "eighty miles was the farthest distance from which carcasses ever came," according to Andrew Wynter (1854, p. 287). With the arrival of the *Strathleven* fifty years later, that distance had been stretched to thirteen thousand miles.

Attitudes towards foreign meat had softened by the time of the exhibition. Refrigerated meat was no longer something people treated with suspicion, unlike the early years of the trade when, as Woolrich put it, "Britishers generally had proclaimed frozen meat unfit to eat and maybe even poisonous" (1967, p. 67). By the 1920s, imported meat was a familiar and accepted part of the British retail landscape:

> Before the war, home and imported supplies were usually handled separately. … To obtain imported meat, therefore, the ordinary consumer had to buy from a shop which traded in nothing else and, owing to the prejudice against imported supplies, often incurred some social stigma in doing so. … Today, however, this is entirely changed; people who, before the war, never ate imported meat, now eat nothing else … and imported meat now has selling opportunities unknown and undreamt of ten years ago. … During the war, meat was allocated under control in such a way that most consumers had, at times, to take their share of the imported article. This helped to remove the prejudice against refrigerated supplies (MAF 1925, p. 465).

Although consuming frozen or refrigerated meat was nothing unusual by the 1930s, refrigerators were still rare in British homes. It had only been seven or eight years since the first models were introduced to Britain, and few households, save the wealthy, would have owned one. Towards the end of the exhibition, two domestic refrigeration units - one compression and one absorption - were included, representing the 'cutting edge' technology of the time. The Museum's Director had approached Electrolux the year before to see if they would be interested in participating in the proposed exhibition and a representative from the company's Refrigeration Department responded to Crawhall:

> I have seen the announcement in *Ice and Cold Storage* to the effect that it is proposed to show Refrigerators. We would very much like to have an opportunity of discussing with you our method of refrigeration both by cooling units and by actual Cabinets and the possibility of these being included in the special section of the Exhibition.[31]

Electrolux offered to loan a working refrigerator, one sectioned to show the mechanism inside and an illuminated diagram illustrating the operation of the hermetically sealed unit. When the exhibition opened, it provoked complaint from the Gas Light and Coke Company for its exclusive focus on electric refrigerators and its failure to include, or even mention, those powered by gas.[32] The organisers did not feel it was feasible to substitute a gas model at that stage, but did revise the explanatory labels in light of the company's concerns to indicate that gas was equally suitable as a power source. The labels attached to the refrigerators informed visitors that "the ice-box has been largely replaced in recent years by cabinets of this type … cooled by a small automatically controlled motor-driven compression unit … [or] an absorption unit," the revised version adding that "the heat is supplied electrically in this case but gas or oil may also be used."[33]

The Director of the Science Museum declared himself delighted by the positive responses "to the excellent balance of the exhibition between the pure science and the everyday application of the subject."[34] That said, correspondence between Crawhall and Electrolux midway through the exhibition suggests that this balance had not been comfortably struck in all respects. There were evidently some challenges in translating between the languages of 'science' and 'the everyday,' for it seemed that members of the public struggled to grasp how a refrigerator operated. As Crawhall commented in his letter, "we are still having a little difficulty with

31 Letter from E. C. Wilson to T. C. Crawhall, 11th July 1933, ECW/DM (archived in Science Museum file 4719 [1962-98] Electrolux Ltd).

32 Letter from C. H. Pearson at Electrolux to T. C. Crawhall, 19th May 1934, CHP/AM (archived as above).

33 Exhibit label text, Science Museum File 4719 [1962-98] Electrolux Ltd.

34 Letter from Colonel E. E. B. Mackintosh to Electrolux, 1st May 1934, Sc.M.4714/11/1 (archived in Science Museum File 4719 [1962-98] Electrolux Ltd).

visitors who are unable to understand the Electrolux circuit, and I shall feel happier when the new transparency is installed."[35]

After the exhibition closed, there was some talk of developing a permanent refrigeration exhibit, though the feeling was this would not be feasible for some years until more space became available. Indeed, it was not until nearly twenty years later that a small display was set up in the museum's 'Heat and Thermal Instruments' section explaining the principles of refrigeration and including a demonstration unit to show the operation of a continuous absorption system. In early 1959, the museum received a letter from a Mr Oldham offering a domestic refrigerator of unusual design. He explained that it was his "memories of the low temperature exhibition which was organised and held in your Museum," the refrigeration exhibition of some twenty five years before, that prompted his donation. The museum was delighted to accept his offer and a 1938 'Zeros' absorption refrigerator made in Dagenham in Essex became the first refrigerator to join the collection of domestic appliances that Mr G. Wilson, Assistant Keeper of Mechanical and Civil Engineering, had taken upon himself to build up, a collection that would grow sporadically over the years and finally be granted gallery space in 1978.[36]

In their visit to the museum, visitors would have been introduced to a set of ideas that had been hundreds of years in the making and which exerted a profound effect upon their daily lives, not least with respect to those foods whose journeys led to their dinner tables. At the entrance to the exhibition visitors would have learned that refrigeration is, strictly, a process of removing heat rather than of adding or 'producing' cold. Passing through the displays, they may have grasped something of the laws of physics, that heat comes from the motion of molecules and that cold is its converse, a relative lack of molecular movement. They may have gained the sense that coldness is a greedy state, one that does not give of its cold but steals heat, for it is heat's nature to flow from hotter things to cooler things. In addition, they may have gained an inkling of the profound challenges inherent in attempts to reverse this flow and overcome the Second Law of Thermodynamics, for the purpose of refrigeration is to persuade

35 Letter to C H Pearson at Electrolux from T C Crawhall, 4th June 1934 (archived as above).

36 Letter to the Science Museum from B C Oldham, 6th February 1959 and letter to B C Oldham from A Stowers, 12th March 1959 (archived in Science Museum Nominal File 9736 [1959/57] B C Oldham).

heat to do what the laws of physics do not ordinarily permit. A refrigerator is a machine designed to make heat move and what makes it such an ingenious device is its subversion of the rule that heat can only flow from hot to cold. It simply becomes a question of scale. By intervening at a finer scale and creatively manipulating the laws of physics, the mechanism makes heat move *from* a *cold* space inside the fridge *to* a *warmer* space outside. The process is fundamentally spatial, albeit at a micro-scale.

The models, the motors, the canisters of refrigerants, the cross-sections and the refrigerator cabinets themselves, accompanied by diagrams and explanations, all attempted to show how refrigeration works and how it keeps things cold. Explanatory panels noted that a pressure differential is an essential part of a refrigeration cycle as it prompts a substance to change state, whether by subjecting gases to sufficient pressure to force them to take a liquid form, or by rapidly releasing liquids into a chamber where they are suddenly able to take up more space. High pressures create high temperatures, whereas expansion causes cooling. This is why an aerosol can feels cold when its contents are released from the pressurised canister, because the gas absorbs heat from the can as it expands. The display also explained that an energy source is needed for a liquid to evaporate because molecules require more energy to change into a gas. Energy in the form of heat is drawn from the liquid's immediate surroundings, which grow cooler as a result, just as, when getting out of a warm bath, water evaporates and cools the skin.

Next to the refrigerators provided by Electrolux, a diagram and description explained to visitors the operation of a compression system. A liquid refrigerant flows through narrow tubes under high pressure. It is injected through a valve into the evaporator, positioned in the freezer compartment. This has larger pipes and lower pressure and the sudden drop in pressure makes the refrigerant expand and convert into a gas, bringing a rapid reduction in temperature. The refrigerant then moves through the heat-exchange tubes inside the food compartment. The food and air inside the cabinet are warmer than the tubes, so, given that heat flows from warm to cold, the heat passes into the tubes, leaving the compartment colder. The refrigerant travels on to the compressor, a motorised pump that compresses the gas and raises its temperature. The heated gas is then pumped through the condenser, a grille of heat-exchanging coils mounted on the back of the fridge. The coils are warmer than room temperature, meaning that the heat is drawn from the fridge into the surrounding air and dissipates into the room, which why a fridge gets warm at the back. The refrigerant condenses back into a liquid, and the cycle begins again. The 'hum' that one hears is the motor coming on every fifteen minutes or so. A thermostat triggers the compressor when the temperature inside the cabinet rises, and shuts off the power again once the correct temperature is reached.

In an adjacent model, visitors were introduced to the principles upon which the absorption refrigerator operates. This method of refrigeration uses ammonia as a refrigerant and relies upon the fact that ammonia has a great affinity for water. Water absorbs large quantities of ammonia at room temperature, but with the application of heat the ammonia is driven off as gas. One chamber, the generator, holds a solution of ammonia and water. As the solution is heated, usually by gas, but oil or electricity can also be used, the ammonia evaporates and escapes into the condenser, a second chamber surrounded by water. Here, the ammonia vapour condenses into a liquid under pressure and gives up its latent heat. The liquid ammonia flows by gravity through a series of pipes and through the evaporator coils in the food compartment. With a drop in pressure, the ammonia boils and turns back into a gas. As it evaporates, it acts as a cooling agent, extracting heat from the interior of the fridge. Finally, the ammonia vapour is reabsorbed by the water and returns to the aqua ammonia solution in the generator from which it initially escaped. And so the cycle continues. Containers of water placed in the tank of liquefied ammonia will freeze as a result of the ammonia drawing latent heat from the water to give it the energy it requires to evaporate. An absorption refrigeration system is sealed and silent; it has no motor, pump or moving parts and relies just upon gravity and a source of heat to operate. In many ways the process seems counter-intuitive. As Bryant (2004) comments: "curiosity began to take hold – how in the world can you put in fire at one end, and get cold out of the other?" Companies have also played on this apparent paradox: "The Flame that Freezes" was Electrolux's famous advertising slogan in the 1930s and a history of absorption refrigeration technology published in 2002 by the Japanese Society of Refrigerating and Air Conditioning Engineers is entitled *Half a Century Cooling with Fire* (JSRAE 2002).

To enable it to 'catch' cold inside the cabinet, a refrigerator needs a seal to keep the warm air out and trap the cool air in. Early models had thick insulated doors with heavy latches but these were superseded by rubber seals containing a magnetic strip. McDermott (2003) refers evocatively to “the rubber seal that runs around the door and opens with a seductive ‘thhpok’, the rubber seal that gives the fridge its identity, that separates the fridge from a cupboard.” It is the seal that performs the crucial spatial separation and marks off the refrigerator as a contained and controlled environment, a space apart. As a device designed to contain cold and to hold cold in place, we can think of the fridge as being a particular sort of space, a type of controlled environment or a ‘microclimate in a box.’ Within this microenvironment, food is preserved by inhibiting the alteration of its material state, something made possible though a kind of transformation-by-proxy whereby the material state of a refrigerant is repeatedly transformed instead. The state of these substances is determined by how they take up space, that is, the amount of space they are permitted to occupy and the degree of pressure to which they are subjected. By juggling relative temperatures in adjacent spaces, the system choreographs the movement of heat, manoeuvring it through a series of heat transfers and siphoning it out of the cabinet. Refrigeration is, therefore, an ongoing achievement and not a fixed or final state.

This ability to control temperature brings with it significant social and spatial implications. By prolonging the life of perishables, the refrigerator challenges the notion of a ‘natural order’ in which food rots, for implicit in its capacity “to slow and even arrest natural processes of decay” is a promise of delaying ‘death’ and decomposition (Higginson & Smith 1999, p. 338). As a space which operates on a different temporal logic to its surroundings, the refrigerator is a box in which the world is made to turn more slowly. As well as ‘slowing time,’ its effect is to ‘shrink distance.’ That which was formerly far away, whether in terms of distance or seasonality, can be brought near, meaning that enhanced mobility of refrigerated foodstuffs could collapse the distance between the consumer and the producer.

This chapter opened with British merchants carrying a perishable commodity, ice, from the shores of Greenland and it closes with the groundwork put in place to create a ‘cold chain’ capable of transporting perishables to and from virtually anywhere, at least for those with access to sufficient capital. As a consequence of controlling the flow of heat within a system, Britons could be fed to a much greater extent by the labour of distant unseen others.

Chapter 3

The Power of Cooling

In this chapter, I examine the ‘ingredients’ and infrastructures, material and conceptual, that were put in place to facilitate the journey of refrigeration into the home. I start by arguing that the emergence of germ theory drew attention to a new scale upon which practices of daily life, and their associated risks, were understood. By grasping the microgeographies of germs, food refrigeration assumed a new importance and the refrigerator was promoted as a technology of public health. I go on to trace various waves of innovation as successive forms of cooling technology, and different sources of power, competed with one another for mass adoption: first natural ice, then artificially manufactured ice, followed by gas- and electric-powered refrigeration. Each of these technologies emerged first in industrial and commercial contexts; each, therefore, had to be ‘scaled down’ before they could be translated into domestic space. As electric refrigeration became the dominant method of cooling in Britain, I focus on developments in electrification and the efforts of the industry to promote appliance use and energy consumption. Growth in appliance ownership was interrupted by the Second World War but I argue that the strategy adopted by the government for postwar housing was influential in the subsequent trajectory of the refrigerator in Britain.

DISCOVERING A LILLIPUTIAN GEOGRAPHY OF GERMS

The relationship between germs and infectious disease is commonly understood in modern western cultures:

> we are taught from a very young age to believe in disease agents that we cannot discern with our own senses … . Parents, teachers, health care professionals, and advertisers all continually reinforce the association between practices such as hand washing or refrigerating food and the preservation of health. The rituals of germ avoidance are so many and so axiomatic that we scarcely can remember when or where we first learned them (Tomes 1998, p. 2).

But learn them we did. They comprise a system of belief that is neither universal nor self-evident but given authority by ‘science’ and the state. Adopted and internalised at an early age, these messages and long-repeated rituals form a kind of 'habitus' of self-surveillance so naturalised it remains unquestioned in adult life (Bourdieu 1977, p. 70-1).

Germ theory explains that diseases are caused by microorganisms and that adopting certain hygiene practices will protect against disease transmission. This body of ideas grew from the work of numerous chemists and physicians: in the 1840s and 50s, William Budd and John Snow both put forward the idea that cholera was spread through contaminated water (Budd 1849; Snow 1855); in the 1860s, Louis Pasteur worked alongside brewers in Paris to study the behaviour of microorganisms during fermentation; in the late 1860s and 1870s Pasteur, in France, and Robert Koch, in Germany, both theorised that similar microbes could be the cause of infectious disease (Latour 1988). These knowledges were neither introduced into a vacuum nor did they abruptly supplant previous ways of thinking. They built upon, even as they competed against, earlier understandings. The notion of microscopic living 'germs' was initially met with scepticism in both lay and medical quarters. Adherents to miasma theory were then in the majority and they ascribed to 'atmospheric' explanations in which disease was attributed to 'bad air' arising from filth and decay. For some decades the validity of germ theory was fiercely contested in Western medicine.

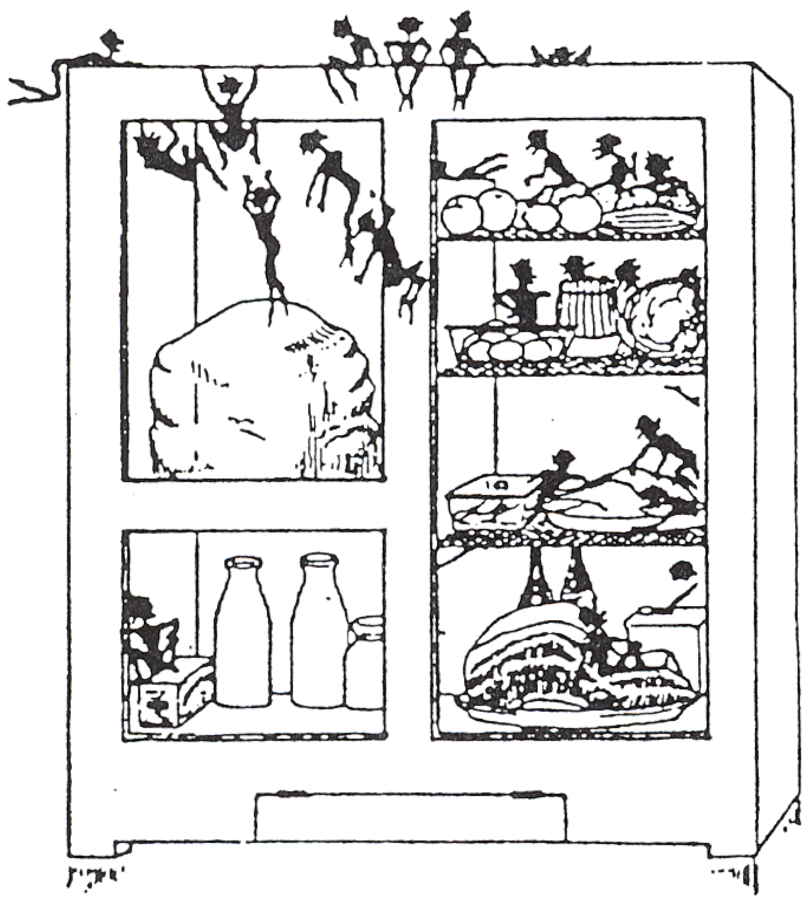
Writing in 1880, physician William Mays declared:

> I hold that every contagious disease is caused by the introduction into the system of a living organism or microzyme, capable of reproducing its kind and minute beyond all reach of sense (Mays 1880, p. 110).

Compounding the difficulty of mobilizing support for these new ideas were issues of scale and visibility. First, advocates of germ theory had the task of convincing scientists and the public alike of the existence of tiny life forms, far too small to see or hear or touch. They existed on a scale that was difficult for most to comprehend for they were not visible without a microscope. The second challenge was for people to reconcile the paradox that *all* human bodies, including healthy ones, harboured these potentially deadly microscopic germs, and yet most did so with no apparent ill effects; "the reality that we now take for granted – that we share our bodies and our homes, our air and food, with a multiplicity of microorganisms, some of which are quite dangerous – they had to be carefully taught" (Tomes 1998, p. 2). Vrooman likened this to trying to convince people "that they coexisted with an invisible world of microorganisms –

like ‘Gulliver among the Lilliputians’” (1895, p. 425), as represented in an illustration in one of Mary Engle Pennington’s bulletins (1927), produced for the National Association of ice industries (Figure 3.1). Thus, people had to come to terms with both the microscopic scale of germs and also their ubiquity. The third task was then to convince people that they could and should take responsibility for their own and other people’s health by performing and avoiding certain practices.

Figure 3.1 Mary Engle Pennington’s depiction of germs



Source: Pennington (1927) *Cold is the Absence of Heat*

In time, the research and the rhetoric of germ theorists proved persuasive. Successful at mustering the necessary ‘allies,’ their explanatory model was manoeuvred into position as the dominant paradigm (Latour 1990, p.23-5). Germs had been made into ‘facts.’ By the 1890s, germ theory had been accepted by scientific authorities and incorporated into medical school curricula, and by the turn of the century recognition of the role of microorganisms in disease was widespread in Europe and the United States. For the most part, people came to accept the existence of a microscopic world within which they had always been immersed but were hitherto unaware. As a mode of understanding available only to the last few generations, Tomes emphasises just how recent it is in historical terms. Germs and their effects were things people had to be convinced of, things they had to learn to believe in.

New bacterial knowledges were accompanied by the birth of a new profession. Bacteriologists set about investigating the conditions in which the microbes responsible for diseases like cholera, typhoid and tuberculosis flourished, and the vehicles, such as sewage, milk or ice, by which they travelled. Public health education initiatives spread the message that germs were transmitted by contaminated food and water, by insects and by people. Through their efforts to compile “an increasingly detailed and accurate road map of the circulation of germs,” the bacteriologists responsible for tracking the movements of these microbes, “could better direct public health efforts to interrupt the way the organisms were spread” (Tomes 1998, p. 6). State officials identified various strategies of containment and purification to regulate both urban spaces and the bodies of the citizenry (Foucault 1991). Interventions came at two complementary sites and scales. Government-level measures included putting in place systems of sewerage and water treatment, rubbish collection and food inspections. Connected with this came closer scrutiny of personal and domestic habits, focused around the cleanliness of homes and bodies, in an effort to encourage the hygienic policing of the self. As Oakley (2002, pp. 100-1) emphasises, it is necessary to recognise that “public health … begins at home, and that most of the housework women do is primarily public health work,” undertaken with the intention of safeguarding the health of the citizen body.

Even before germ theory, it was common to believe that diseases originated in some way from homes. Nineteenth-century Sanitary Science, with its focus upon water, plumbing, airborne infections and risks from human waste, regarded public sanitation as the basis upon which the nation's health was founded. 'House diseases' were understood to result from defective plumbing and ventilation or from poor housekeeping and there were particular anxieties about toilets, sinks and sewers, the openings into the home that people feared were access points for 'sewer gas' (Eassie 1872). Sanitary science reformers had already exerted considerable influence upon the design and organisation of the home and the ways in which domestic chores were carried out. Germ theory built upon these preoccupations but expanded the focus upon domestic hygiene. Government-led public health initiatives had a strong domestic orientation, intent not only to influence the material infrastructures of people's homes but also to regulate the behaviours that went on within them. Ordinary daily practices were revealed to be much more risky than formerly assumed and there was heightened concern about unwashed hands, shared utensils, coughing, sneezing and spitting, all of which were reconceptualised as risky behaviours.

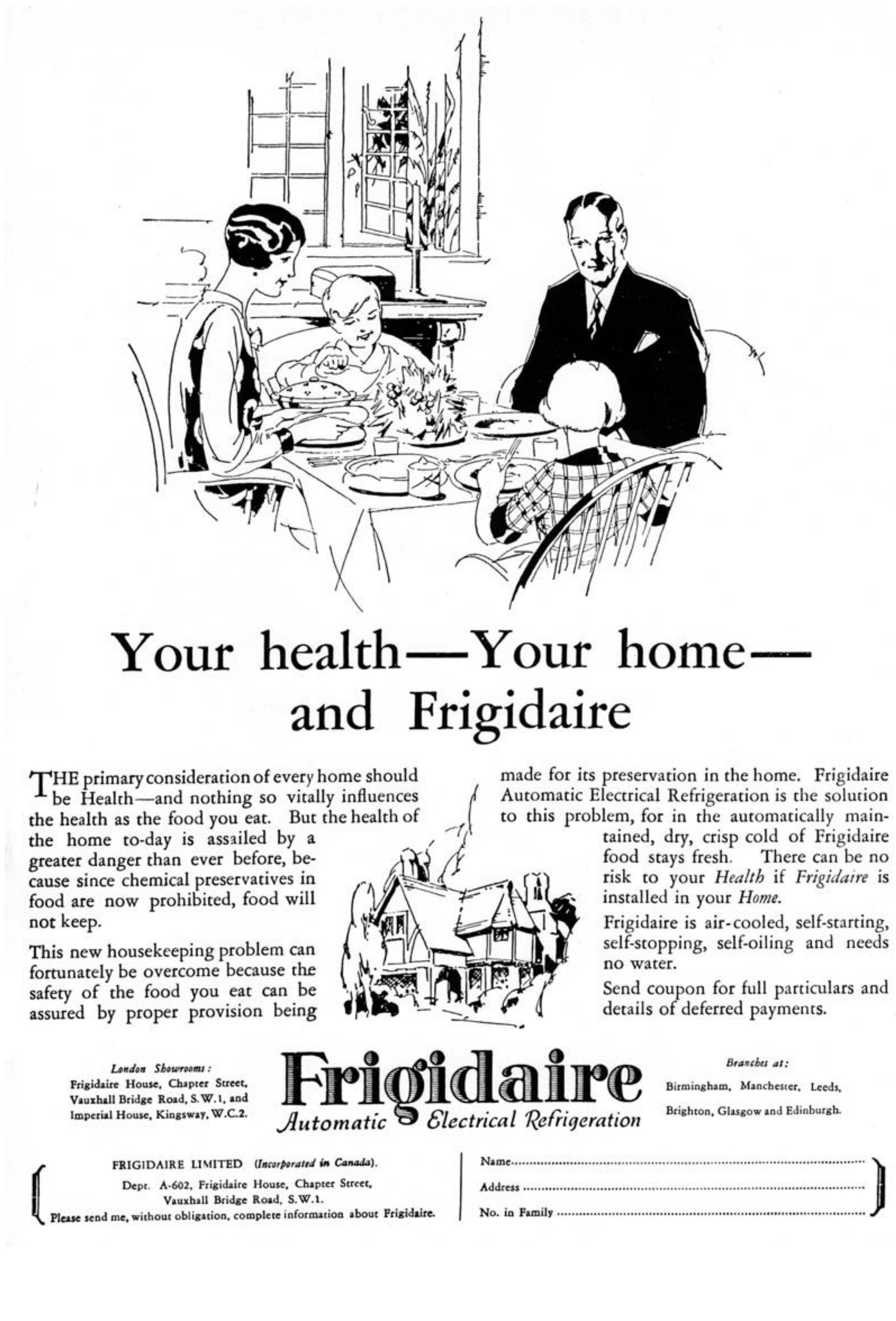
Intimately bound up with what Foucault characterises as a form of governmentality, public health initiatives hinged upon the government of individual bodies, both by the state and by individuals themselves (1991). Forty (1992, p. 160) notes that:

> because most of the newly identified carriers of disease were beyond the scope of state or municipal action, there was no means by which direct public intervention could bring about lasting improvements. As cleanliness of houses and bodies depended upon individuals, the only means of reform was through education.

Practices promoted by officials aimed to educate people to police their own conduct more stringently. In discourses of sanitary science, men and women both had roles in improving hygiene, but "the kind of cleanliness required … had more profound implications for women," for "on a daily basis, the oversight of sanitary practice fell most heavily and unrelentingly on the women in the family" (Tomes 1998, p. 10 & 65). Men's roles were in the areas of home repair and plumbing while women's duties included food handling, housework, child care and nursing, reaffirming traditional assumptions that women carry primary responsibility for maintaining family health and wellbeing. Scientific discoveries of a world of microorganisms brought new knowledges but also new burdens to Victorian women. Guarding against germs demanded constant vigilance, scrupulous cleanliness and the unremitting disciplining of bodies and domestic spaces.

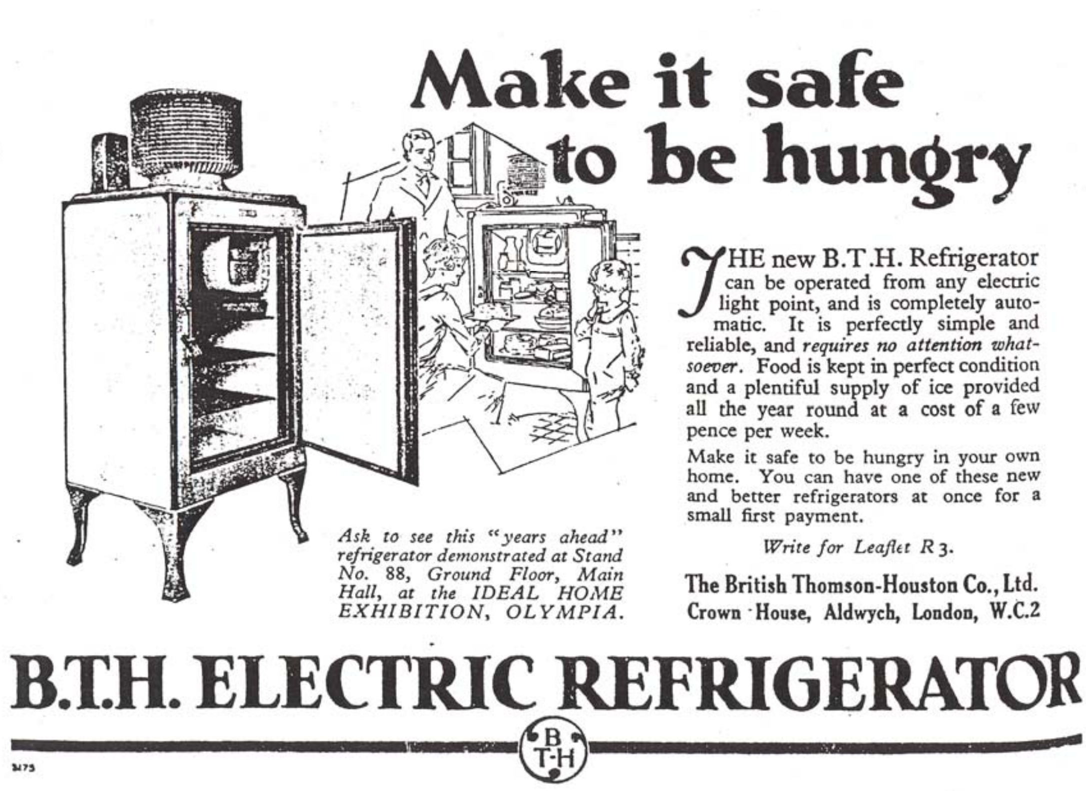
Along with the vacuum cleaner, the refrigerator was envisioned as a tool to combat germs. It enabled people – specifically women – to store food in new and more hygienic ways in order to minimise bacterial contamination. Advertisements for iceboxes and refrigerators played heavily upon these anxieties, the inference being that a good wife and mother would invest in such a product to safeguard her family's health. Discourses of food safety remain a dominant theme throughout the history of refrigerator advertising and became particularly pronounced after regulations passed in 1926 prohibited the use of certain additives. Without the protection of these preservatives, the fear was that food would be increasingly vulnerable to bacteria. One's health, we are told in one advertisement, "is assailed by a greater danger than ever before, because since chemical preservatives in food are now prohibited, food will not keep," at least not without the purchase of that Frigidaire (Figure 3.2).

Figure 3.2 Frigidaire advertisement, *Good Housekeeping*, 1926



“Make it safe to be hungry,” BTH similarly advocated in its advertising campaigns in 1932 (Figure 3.3). An advert from the White Enamel Refrigerator Company around the same time in the United States makes the risks more explicit still: “Infant mortality would be greatly reduced,” it declared, “if all homes were equipped with Bohn Syphon Refrigerators,” contending that ‘impure milk’ lay at the heart of much ill health in early childhood.

Figure 3.3 BTH advertisement, *Good Housekeeping*, 1932



Used with permission of telent Ltd.

Growing awareness of food borne illness prompted better food handling practices. Previously, contamination was not uncommon, due to a lack of awareness that leaving food uncovered on the table between meals, or storing it at uneven temperatures, made it vulnerable to bacterial growth. Bouts of ‘summer complaint,’ a serious and even fatal illness, particularly to babies and the elderly, were fairly common.[37] It was usually attributed to the heat interfering with digestion until bacterial knowledges became available to suggest that food poisoning might be responsible.

Embedded in the mundane practices of cooling, cleaning and caring, we can trace some of the journeys of scientific knowledges and their incorporation into daily practice. "Bacterial knowledge moved from the laboratory to the parlor" and became domesticated into what Tomes terms the 'working hypotheses of everyday life.' Her intention is "to challenge the implicitly gendered division of knowledge that regards as significant what Pasteur did in the laboratory but dismisses as inconsequential what a public health nurse or housewife did with his insights" when those knowledges and practices were taken into the "domains traditionally designated women's work and consequently ignored or trivialized" (Tomes 1998, p. 14).

ICE USE IN THE HOME

Domestic heating, cooling, drainage and ventilation, topics of prime concern to nineteenth-century Sanitary Scientists, were the focus of Eassie's *Healthy Houses* (1872). In his text he also comments that:

> I cannot conceive even a healthy home to be thoroughly complete if it lack the means to cool any particular material which may be in requisition. … The power to cool the air of a particular chamber, or substance, or liquid … is becoming an absolute necessity. … No one can eventually be more benefitted than the housewife, by the successive triumphs of our ice engineers (1872, p. 205).

Already in this 1872 account, technologies for domestic cooling are being framed as 'necessities' to preserve foodstuffs, create refreshing summer drinks or soothe the sick. The housewife is clearly the one responsible for such activities for it is she who benefits. In his account of the various forms of cooling that 'ice engineering' has made possible, Eassie acknowledges the role that class distinctions played in where and how one got access to cooling. He discusses large-scale construction projects such as excavating ice-wells and building ice-houses, but, conscious that such schemes would only be pertinent to certain of his

37 Estimates suggest that epidemic diarrhoea may have been responsible for around one third of infant mortality during the nineteenth century. In the 1880s a link was made between this condition and food contaminated with the Salmonella bacteria (Hardy 1999).

readers, he also makes a point to cover “the common freezing-powder machines and ice-chests” for the benefit of “the general reader.”[38]

Ice engineering

Britain’s icehouses date back to the late-seventeenth century. Evidence from 1660 indicates that there were icehouses in London’s Green Park and John Evelyn (another founder member of the Royal Society) planned to include a chapter called “Of Rock, Grotts, Cryptae, Mounts, Precipices, Ventiducts, Conservatories of Ice and Snow, and other Hortulan Refreshments” in the three-volume *Plan of a Royal Garden* he began in the 1690s but never completed (Cooper 1997, p. 1). Early ice houses took the form of a pit around twenty feet deep, insulated with cavity walls and a domed roof covered with earth or thatched with reeds. Entrances faced north and, as icehouse design grew more elaborate, two sets of doors were included to create an insulated corridor as an airlock to keep warm air out. References to icehouses began appearing in gardening periodicals in the eighteenth century and, in his 1818 book *Rural Residences*, John Papworth comments that:

> the ice house forms an excellent larder for the preservation of every kind of food that is liable to be injured by heat in summer; thus fish, game and poultry, butter, etc., may be kept for a considerable time: indeed in London they are used for such purposes by persons who deal largely in either fish or venison (cited in Hardyment 1992, p. 105-6).

Not just a storage space for ice itself, these icehouses doubled as iced larders. Papworth explains how different degrees of cooling can be achieved, according to the proximity to ice. Foods may be frozen by storing them on a surface directly over the ice, or the outer corridor of the ice house may be fitted with shelves to create a chill room for those items better chilled than frozen.

In 1845, Jane Loudon discussed the ice cellars found on some country estates. Built directly adjoining the house, ice cellars were cooler than conventional kitchen spaces and more

38 He makes his desire to access a general readership explicit in his closing codicil, explaining: “My object has been to write a popular treatise which shall embrace all the sanitary requirements of a modern habitation, and to offer the result of my labours in this direction in a work at a price within the reach of everyone” (Eassie 1872). Although his intention was clear, it is hard to know how diverse his readership would have been in practice.

convenient than an icehouse usually located some distance away. They were designed with cavity walls infilled with charcoal insulation, two sets of doors to minimise heat transfer, a pit filled with ice and shelves on which to store food and drink. “The modern ice cellar,” Loudon explains, “is very useful for keeping cool water, butter, and other articles of daily consumption, which can be fetched out of it when they were wanted, as easily and expeditiously as they could be out of a common dairy or pantry” (cited in Hardyment 1992, p.106). As such, it formed an intermediate space, one moving closer to the home than the icehouse, but not yet fully integrated into domestic space. Loudon described them as “a more modern invention” than the “old-fashioned ice house” so, at the time she was writing, these represented the latest in technologies of convenience in the homes of ‘early adopters’ and the ‘super rich.’

The domestic icebox: scaling down the ice house

In May 1845, the *Illustrated London News* brought word of a cooling device that was in widespread use in the United States:

> In America every family has a ‘Refrigerator,’ or portable ice house. … In these miniature ice houses, every American housekeeper, through the warm season, places provisions and fruits of every kind; keeping for weeks if desirable, large joints of meat and every species of comestible. A block of ice, weighing a few pounds is placed within it and is a supply for several days (cited in Cooper 1997, p. 73).

In this account, significant shifts were taking place in the scale and location of cooling. We see the miniaturization and mobility of technologies of cooling as they become domesticated and brought inside the home. Eassie remarks upon this re-scaling and re-location of refrigeration when he comments that:

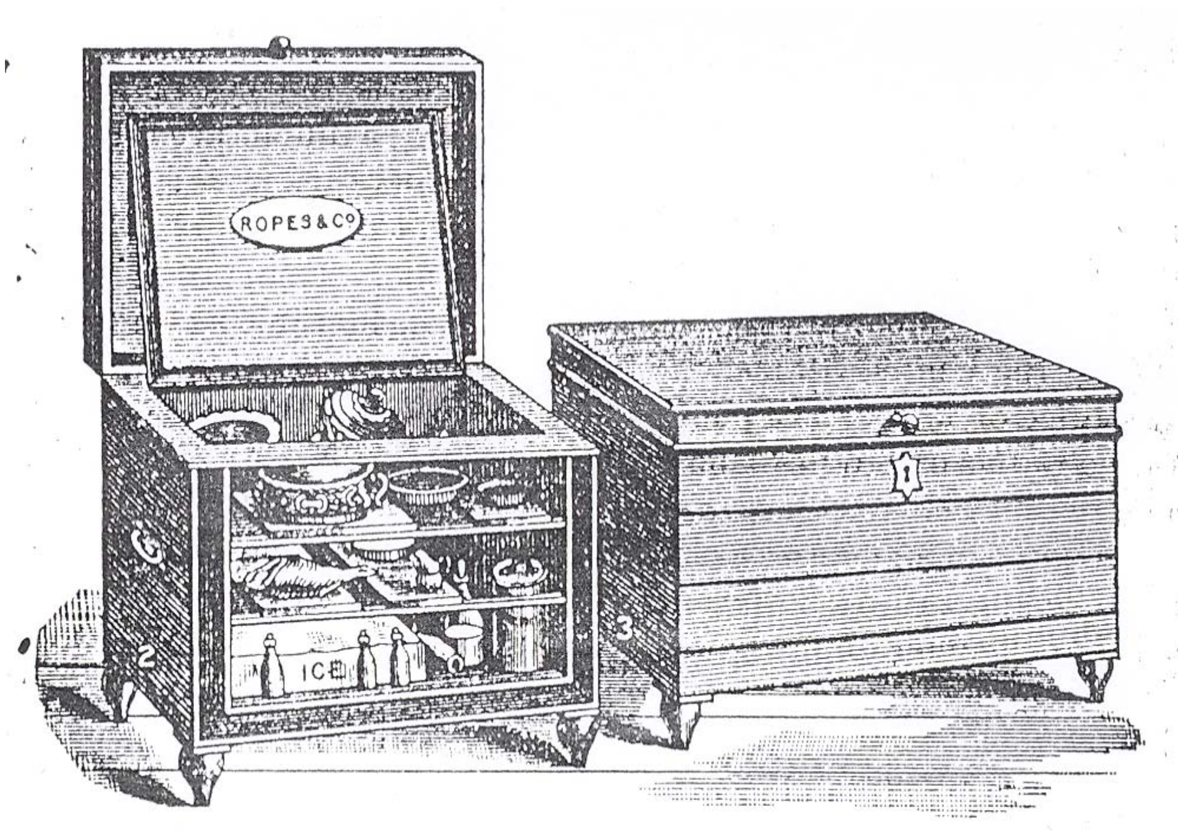
> The ice refrigerator, of some ten cubic feet, therefore, has already largely replaced the ice-house of a hundred times the size, and the exchange is particularised by increased comfort as well as saving (1872, p. 206).

Here, the icebox is a modern technology which promises economy and convenience. In newspapers we see explicit comparisons being made with refrigeration methods overseas, suggesting that Britons were being exposed to new knowledges and practices imported from the United States. Few in Britain were in a position to have an icehouse of their own.

However, as the trade in ice increased, supplies to urban areas enabled those without the means to store ice in bulk to purchase it in small quantities on a regular basis.

The earliest iceboxes would have been have been improvised using crude wooden containers lined with straw or sacking. Purpose-made iceboxes for domestic use date back at least to the 1830s and 40s and 'ice chests' or 'ice caves' were included among the goods on display at the Great Exhibition in London in 1851. These took the form of zinc-lined chests which opened at the top. Ice was placed at the base of the chest and food was stored around it or on shelves above (Figure 3.4).

Figure 3.4 Illustration of iceboxes from Ropes & Co. sales catalogue



Source: United States Department of State 1890, p. 175

Around the turn of the century, iceboxes were redesigned to house the ice in a separate compartment at the top of the cabinet, which was connected with vents to one or more food compartments below. This redesign arose from a more comprehensive understanding of the way ice actually cools. Earlier models worked on the principles of insulation and kept ice well insulated with straw or fabric in the hopes of preventing the cold from escaping. This represents a long-standing point of confusion, one the Science Museum exhibition in 1934 sought to clarify by emphasising that “ice placed in an ice box does not cool by reason of its low temperature but by reason of the fact that it is changing state from solid ice to liquid water” (Crawhall & Lentaigne 1934, p. 4). In order to change state – to melt – the ice absorbs energy from its surroundings by extracting heat from the food and air inside the ice box. The realization that warm air rises, cold air falls and effective cooling requires good air circulation, prompted designers to reposition the food below the ice. As a consequence, the air around the ice would be cooled and fall to the lower compartment where, warmed by the foods, it would rise again, further melting the ice. Thus, the construction of cooling devices was shaped by more sophisticated knowledge of the behaviour of heat.

Some enamelled steel iceboxes were produced, but most were wooden containers lined with galvanised zinc, tin, slate or later porcelain, and insulated with materials like cork, felt, sawdust, charcoal, flax straw or even, on occasion, seaweed. Quality varied considerably from cheap and shoddy boxes made of pine to better quality hardwood models. Some had multiple compartments and sophisticated arrangements of vents and drainage pipes and those elaborately carved and highly polished models made from oak, walnut or mahogany were clearly intended for show. Eassie includes some prices for “the commoner ice-chests at random from two London lists,” implying that there would have been a range of retail outlets for this item, at least in Britain’s capital (1872, p. 222). Chavasse & Co. is one of the two lists he mentions and Figure 3.5 shows a slightly later model manufactured by this company in London, a few years after Eassie’s publication. It takes the form of a wooden box, approximately two and a half feet high and two and a half feet high wide. The Clifton’s patent ‘dry cold air’ system mentioned on the porcelain nameplate (Figures 3.6) used a series of louvres or flaps at the back of the chest to aid air circulation. It is noteworthy that this pre-mechanised and British-made icebox was known as an ‘American Refrigerator.’[39]

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39 Chavasse & Co stocked a range of models from boxes just under two feet square to substantial chests over four feet long and three feet high. For an “improved ventilated ice chest, provision preserver and wine cooler, fitted with block filter and tank for Drinking Water,” the sophisticated hi-tech version of its time, he directed readers to Brown Bros & Co’s lists (Eassie 1872, p. 223).

Figures 3.5 & 3.6 Dry Cold Air American Refrigerator manufactured by Chavasse & Co., c.1880, from the Science Museum's Collection.

Source: own photographs

Eassie's section on iceboxes appears towards the end of his chapter on domestic cooling. The entry is brief. He starts by commenting, "I have nowhere yet alluded to the ice-chest," and goes on to explain, "neither is it my intention to describe any one of the score now in use, since their construction must be known to all" (1872, p. 222). Evidently, Eassie took the icebox to be too familiar to the 1872 audience for whom he writes to warrant further details. Just how widely iceboxes were used in Britain at this time is hard to know for sure, particularly as a somewhat different picture is painted by the Special Consular Report on 'Refrigerators and Food Preservation in Foreign Countries,' produced by the United States Department of State in 1890. It provides a useful insight into domestic cooling from the perspective of American Consuls in various countries around the world. In late 1889, Consuls were surveyed about local refrigeration practices as part of an information gathering exercise to investigate potential export markets for American manufactured iceboxes. They were asked about the extent to which iceboxes were used in their region; the source and cost of ice; the size, style and price of iceboxes; where they were produced; and the methods of food preservation practiced in their absence (United States Department of State 1890, p. 3). Responses from eleven English towns and cities were included in the report and in each case respondents commented that iceboxes were rare in private homes.[40] The reports from Birmingham, Bradford, Plymouth and London said that iceboxes could only be found in a few of the wealthier households for, although “regarded as household necessities in the United States, they are here considered articles of luxury” (p. 169). In Leeds, the Consul believed that there was moderate use in the town but virtually none in the country, while Sheffield’s Consul said that, to his knowledge, they were unknown in private homes entirely (p. 171 & 201).

Initially, domestic consumers obtained their ice from fishmongers because there were few or no dedicated ice dealers. The United States Consul in Leeds suggested that “this fact alone would seem to show how far from general is the use of ice in the community” (p. 173). The low demand for ice was attributed to a mild climate that remained relatively uniform year round. Ordinarily, foodstuffs kept quite adequately without an icebox because only a few days, or at most a few weeks, each year were deemed warm enough to warrant one:

> The climate of this country is not the most favorable to insure the general use of refrigerators. The temperature rarely exceeds 85°F. Warm periods of long duration seldom take place. This probably accounts for the fact that refrigerators have not been adopted into general family use, even by persons of fair means (p. 169).

Instead, perishable foods were bought in small quantities for immediate use, or, where the size and layout of the house permitted, stored in cellars:

> Every house occupied by persons whose circumstances would warrant the outlay necessary to obtain a refrigerator is provided with cellarage, where meat, vegetables, and so forth are kept before being used. These cellars, while below the exterior level of the ground, are generally well ventilated, and, being furnished with stone tables, they serve the purpose of a cold-air chamber, with the great advantage of abundant space (p. 173).

Why, then, would such households feel the need to purchase a small cooling space when they had at their disposal cold spaces of ample size ready-built into the structure of the house?

Despite Eassie’s insistence that no home could be complete without some form of cooling, this priority was not one universally shared. Overall, Weaver and Dale note, “the British showed far less enthusiasm than the Americans for storing and making ice” (1992, p. 60). British

40 The eleven were Birmingham, Bradford, Bristol, Falmouth, Leeds, Liverpool, London, Newcastle-upon-Tyne, Plymouth, Sheffield and Southampton.

interest in refrigeration concentrated on industrial rather than domestic applications. Equipment for industrial and commercial users would have been custom made by specialist firms in each region. As to the sources of domestic iceboxes, the Special Consular Report made reference to a handful of manufacturers in London, but it is evident that many iceboxes were also being imported from Canada and the United States from the 1880s through the 1920s; the British Canadian Export Co. Ltd. of Canada, for instance, advertised in *Good Housekeeping* and sold Barnet iced refrigerators through an agent in London.

The Leonard Refrigerator Company, set up in 1881 by Charles Leonard in Grand Rapids, Michigan, went on to become the world's largest manufacturer of iceboxes and a prominent supplier to British consumers. The models imported from North America were widely considered superior to British-made versions and Consul Jarrett in Birmingham explained that:

> Though the general features of smaller refrigerators adapted for family use are similar to those of American make, there is a marked difference in their construction, the American being better in design and utility. I may add that the price of American refrigerators is lower than the price of similar ones of English make (p. 168).

Even with American iceboxes undercutting British prices, contributors to the report were not optimistic about the potential for increased sales in Britain, partly due to Britain's temperate climate, but mainly due to an assumption that iceboxes would always be reliant upon imported ice, which, by virtue of its transportation costs, would continue to command an inflated price. Ice was being manufactured in Britain by this time, but production levels were evidently still too low to suggest that artificial ice might threaten natural imports. In addition to such practical and economic constraints, there was, warned Consul Folsom of Sheffield, the issue of the British temperament:

> The inhabitants are so conservative in their views, and so disinclined to made radical changes in anything, that I doubt if even so useful, and to us so necessary, an article as the refrigerator could be successfully introduced (p. 201).

In his view, prospects for icebox use would remain limited to just a wealthy few because Britons were singularly unable to appreciate the value of a device that Americans took to be self-evident. The icebox was positioned in markedly different ways in relation to the notion of 'necessity' in each country, emphasising the extent to which constructions of 'common sense' are culturally specific. Only Consul Wigfall from Leeds foresaw a growing, albeit gradual, demand. He observed a tendency in Britain for living standards to creep

> continuously in the direction of luxury. … Trade of all kinds is flourishing, and there could hardly be a more propitious time than the present for the introduction into general use of anything designed to add to the comfort of living (p. 173).

The icebox, he predicted, would become an increasingly desirable consumer technology, one destined to inch within reach of an ever larger population.

ELECTRIFYING THE ICEBOX

Three years after the publication of the Special Consular Report, the opening of the World's Columbian Exposition leads us back once more to Chicago. Hubert Bancroft's account in *The Book of the Fair* (1893) provides a valuable snapshot of 1890s 'cutting-edge' technology. He writes that in the building devoted to Manufactures and Liberal Arts,

> adjoining [the] display of stoves and furnaces … and everything else suggestive of heat, are those which apply to ice and the preservative qualities of cold. Here every appliance is at hand, from the plain ice box to the complicated refrigerator with half a dozen walls. Miniature specimens, pretty enough for a piece of household furniture, stand side by side with mammoth structures for the preservation of meat and beer (Bancroft 1893, p.165).

Equipment for manufacturing ice was located in a fully operational Cold Storage Building, purpose built for the Exposition, which gave working demonstrations of ice production and "displayed the various methods of artificial freezing, and the several processes for the preservation of such perishable articles as fruit, meat, eggs, and butter" (p. 328). The Fair captures an interesting point in the relationship between electrification and refrigeration. A comprehensive selection of cooling devices were on display, but here the 'complicated refrigerator' is still an icebox, albeit a sophisticated and well-insulated one. Electricity drove industrial refrigerating machinery in breweries and meat stores and it powered the plants that made the ice delivered door to door for household use, but although refrigeration technology was quite highly developed by this time, the machinery itself had yet to be scaled down sufficiently to permit mechanical cooling on a domestic scale. Domesticating the electric refrigerator depended upon both the 'miniaturisation' of the electric motor and the expansion of domestic electrification. Small electric motors were being used in washing machines and vacuum cleaners in the first decade of the 1900s, and the first household refrigerators followed soon after, but it was to be some time before an electricity supply was widely available in British homes.

Mobilising electricity

Electricity started becoming available in British urban centres towards the end of nineteenth century. Thomas Edison (1847-1931) was a key figure in the development of direct current (DC), upon which early electrical equipment was based. He demonstrated his DC power generation system at the Paris Exhibition in 1881 and at an electrical exhibition staged at Crystal Palace in London the following year (Roberts 1989, p. 75). One of the principal constraints of DC power was the difficulty of transporting electricity more than a few miles. Electrical resistance meant energy was lost as heat when electricity was moved and those losses increased with distance. Transmitting electricity at low voltage is highly inefficient and requires extremely thick wires to reduce resistance and minimise heat loss, but at high voltage it carries the danger of electrocution. DC current could not (at that time) be converted to different frequencies, so Edison's power generation system was a necessarily localised affair, with electricity generated close to where it was consumed (Hannah 1979, p.10). As demand for electricity grew, it seemed impractical to have power generating plants located every few miles. Nikola Tesla (1856-1943), a Serbian-American engineer and inventor, was convinced that the solution lay in 'alternating current' (AC). With DC, the direction of current remains constant whereas AC alternates many times per second,[41] which has the effect of radically reducing electrical resistance. Although the principles of AC were well known theoretically, a successful operating system had not been built prior to Tesla.

In a paper to the American Institute of Electrical Engineers, Tesla outlined his method for "A New System of Alternating Current Motors and Transformers" (Tesla 1888). His innovation was to develop a system where the frequency of electricity could be altered using a simple transformer. Effective transformers had recently been developed and Tesla used one to step up

41 This is why AC-powered appliances can give off a characteristic hum.

the voltage for transmission and a second to convert it back to low voltage for safe use.[42] The radical reduction in resistance that AC offered, along with its ease of conversion, vastly enhanced the mobility and 'reach' of electricity. AC offered a way to overcome the distance constraints of Edison's system and make long-distance distribution feasible, meaning that power generating plants would not have to be located in close proximity to sites of high demand. Although transmission distances were fairly circumscribed initially, what AC electricity offered was the potential to be transported at high voltage and low current over almost unlimited distances.

Nevertheless, adoption of AC technology was slow and the two systems ran in parallel for some time because investment had already been made in DC infrastructure. The Exposition in Chicago marked an important moment in the history of electricification. It was the occasion upon which an AC system was showcased to the public and also the first World's Fair to feature a building dedicated to electrical exhibits (Bancroft 1898). Bancroft stressed that the use of electricity for purposes other than the telegraph – or, indeed, the very idea that it might have other uses – was extremely recent in origin. The first application of electric power in the home was in the form of sewing machines with battery-powered motors in 1886 (Adams 1995, p. 47). In his chapter on the Electricity Building at the Fair, Bancroft draws particular attention to electrical apparatuses for domestic use, advising that "the most interesting application … may be studied in the north gallery, where the housekeeper may see how her home can be comfortably warmed by electricity, and how her cooking may be done expeditiously and scientifically," aided by the multiplicity of electric kettles, griddles, ovens, coffee pots and irons newly at her disposal (1893, p. 422). "Electricity … made seemingly everything run at the Exposition, including the ornamental fountains, the elevated railway … massive searchlights, switchboards, elevators, automatic door openers, cooking stoves, cash registers, and every conceivable household appliance" (Adams 1995, p. 49), apart, that is, from refrigerators.

The success of AC at the Fair was key to establishing its supremacy over DC. Tesla and Westinghouse were approached by The Niagara Falls Commission, headed by Lord Kelvin,

42 These had been designed and patented by William Stanley (1858-1916), Chief Engineer at Westinghouse.

and offered the contract to design a power station to generate electricity from Niagara Falls, which was the first large-scale application of AC (Roberts 1989, p. 80). Edward Dean Adams, President of The Niagara Falls Power Company, claimed his company's decision to adopt AC "settled all doubt as to the universal adaptability of alternating current" (Adams 1927, p. 369). The backing of this influential body helped recruit more supporters to AC, laying the foundation for its adoption not only in the United States, but across Britain. Tesla and Westinghouse had won 'the battle of the currents' and AC became the standard for contemporary domestic electricity supply. In Britain, electrification was initially used by industry and for street lighting. The 1882 Electric Lighting Act made provision for local authorities and supply companies to set up local electricity generating systems. Most larger towns had central stations by 1903, but electricity did not reach smaller towns and rural areas until much later (Roberts 1989, p. 78). In the 1910s, individual homes were starting to be wired for electricity, though by the end of the decade domestic use still represented a very small proportion of consumption, with just 6% of British homes having electricity supply (p. 94).

The relatively low number of domestic appliances users was partly a result of the way in which electricity supply was organised. After the 1882 Act, supply companies created local generating plants. Set up separately and operated independently, these ran on largely arbitrary frequencies. The supply companies had little reason to be concerned about the compatibility of their frequencies with those elsewhere, given that no national network had yet been envisioned. The arrangement became problematic only when viewed on a larger scale. Pursell (1999, p. 50) notes the unintentional chaos that emerged when a 1919 assessment revealed a picture in which "642 undertakings (some AC, some DC, some both) supplied electricity at seven different frequencies and forty-four different voltages." Appliances that operated at different voltages could not be connected to the same power lines, meaning that separate lines were needed for lights, which ran on low voltages, and things like heaters, whose voltages were much higher. Householders could be understandably wary of investing in appliances designed to run on the specific voltages available where they lived because, should they move house, there was no guarantee that their appliances would be able to accompany them elsewhere (Pursell 1999, p. 51). As a consequence, in the days before standardisation, electrical appliances were surprisingly immobile and place-specific technologies, 'attached' to certain localities by virtue of their operating frequencies.

The development of mechanical refrigerators

Industrial refrigeration systems were being used from the mid 1800s, but it was not until the eve of the First World War that small mechanical refrigerators for domestic use began appearing. As engineer Alan Cooper explained to me, industrial refrigeration systems were large and complex machines, custom built for each site and usually weighing several tons. They were manually controlled and had to be operated by skilled technicians. To make the transition to household use, machines would not only have to be many times smaller, they would also have to run automatically, rather than expecting the user to stop and start them or regulate the flow of refrigerant to the evaporator. Prerequisites for domestication were that the machines be inexpensive, automatic and straightforward to use.

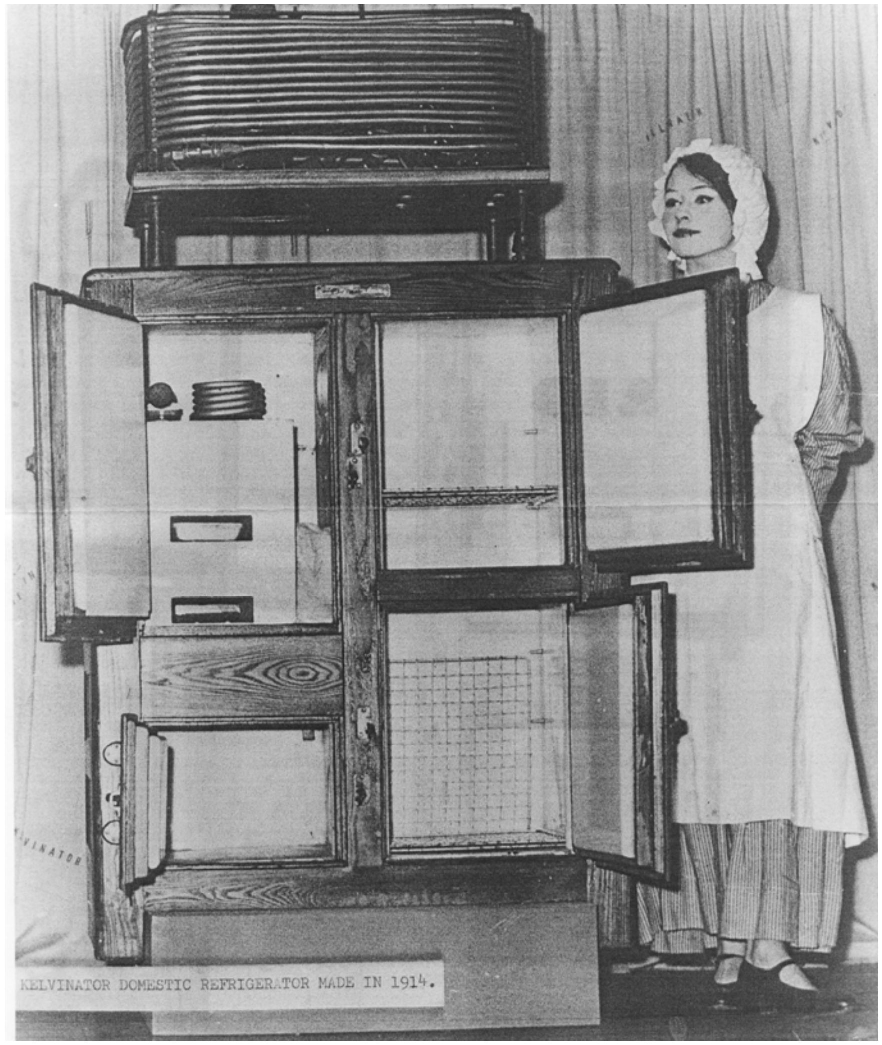
Fred Wolf, a Chicago engineer who had designed refrigeration systems for breweries, purchased the US and Canadian rights to Carl Linde's patents. He was one of the first to start scaling down compressors for domestic use and around 1913 he developed the 'Domelre,' which stood for DOMestic ELectric REfrigerator (Anderson 1953, p. 95). This was a sulphur dioxide compression mechanism that could be mounted at the top of any icebox. Powered by an electric motor and designed to run off a low current, it could be plugged into a light socket. Not long after the launch of the Domelre, Kelvinator and Frigidaire both entered the US refrigerator market with compression machines and, along with manufacturers like General Electric and Electrolux, became some of the most dominant companies in the domestic refrigerator market. Interestingly, none were former makers of industrial refrigeration machines and domestic refrigeration evolved as a largely separate market. Within ten years, over fifty companies were producing refrigerators (Matly 2005, p. 34). Carl von Linde is said to have described Britain as "the cradle of refrigeration" in a 1902 paper to the Cold Storage and Ice Association, but, while mechanical refrigeration might have been born in Britain, it was in the United States that the domestic refrigerator 'grew up.'

Edmund Copeland was working for General Motors when he met Nathaniel Wales, an engineer, inventor and persuasive advocate of mechanical refrigeration. As Copeland recounts: "I spent considerable money on his different ideas … [and] he talked me into electric refrigeration" (Beckman, undated, cited in Cooper 1997, p. 75-6).[43] Convinced that refrigeration had a future, Copeland tried, unsuccessfully, to secure financial backing from William Durant, General Motors' President, before approaching the wealthy industrialist, Arnold Goss. Copeland and Goss set up in partnership, with Wales as Chief Engineer. They incorporated as the Electro-Automatic Refrigerating Company Inc. but later changed the company name to Kelvinator, in honour of Lord Kelvin. The Thomson advertising company of New York was brought on board to develop an advertising campaign and was credited with coming up with the terminology 'Kelvinator,' 'Kelvination,' 'Kelvinating' to stand for 'refrigerator,' 'refrigeration' and 'refrigerating,' terms that became sufficiently successful to make their way into everyday terminology (Refrigerator Research Museum 2007).

The company initially experimented with absorption methods but ultimately settled on a sulphur dioxide compression machine (Figure 3.7). Refining the automatic controls and ironing out refrigerant leakage problems with their prototypes took time, but by February 1918 they had a saleable model and the Kelvinator electric automatic refrigerator entered the market (Cowan 1985a, p. 206). Sixty seven Kelvinators were sold that year (Beckman, undated, cited by Cooper 1997, p. 76). Joseph Schlacks, the retired head of McCord Manufacturing Company of Detroit, purchased the first machine and following his lead the earliest mechanical refrigerators were installed in wealthy Detroit homes.

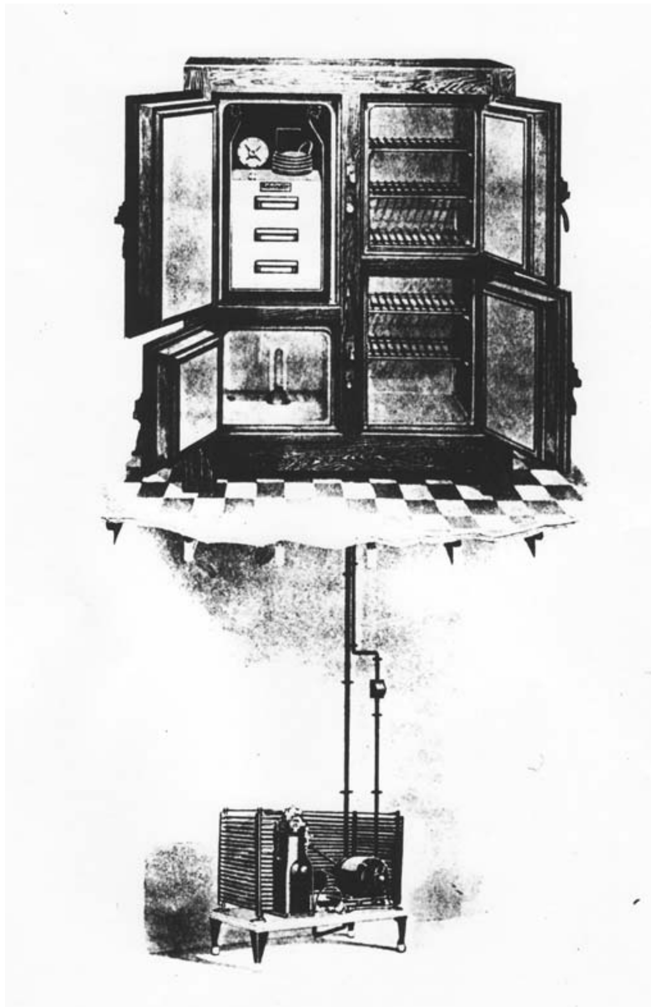
43 Undated manuscript on Edmund J. Copeland, written by James W. Beckman. On file in the basement archives of the Burton Historical Collection, Detroit Public Library.

Figure 3.7 The first Kelvinator refrigerator, c. 1914



The first generation of household refrigerators were large wooden cabinets with 'remote' refrigeration mechanisms. These were installed in existing iceboxes with the motor, compressor and condensing unit located outside the cabinet, either adjacent to it or in a separate room; for example, equipment could be installed in a basement and connected by pipes to a converted icebox in the kitchen above, making it a distributed technology spanning different domestic spaces (Figure 3.8). Strictly, therefore, the term refrigerator originally referred to the 'naked' refrigerating mechanism, rather than the cabinet with which it was later clothed.

Figure 3.8 A Kelvinator refrigerator with remote unit located in a basement (Kelvinator 1977, unpaginated)



Alongside its conventional iceboxes, the Leonard Refrigerator Company produced a line of cabinets designed to house electrical refrigeration units. Kelvinator's realisation that its machinery was most frequently installed in Leonard iceboxes led first to a more formal collaboration and then a merger as Kelvinator bought the Leonard brand. In turn, cabinets and compressors, once produced separately, likewise merged to create self-contained 'electric iceboxes.'

In 1916, Alfred Mellowes formed the Guardian Frigerator Company in Fort Wayne, Indiana, to manufacture a self-contained water-cooled refrigerator (Gordon 1984, p.7). This took the form of a wooden cabinet with a massive cast-iron refrigeration mechanism weighing nearly two hundred pounds located at the base. Although his design did go into commercial production, records at the Refrigerator Research Museum in Brighton, Michigan, indicate that only thirty or so of these individually-designed refrigerators were ever produced. Unable to achieve the economies of large-scale production, the company wound up facing substantial losses. Those economies only came after William Durant, notwithstanding his earlier lack of interest in refrigeration when approached by Copeland, bought the Guardian Frigerator Company in 1918. He renamed the company ‘Frigidaire’ and sold it on to General Motors the following year. Thereafter, Frigidaire operated as a subsidiary of General Motors in Detroit, until production was moved to Dayton, Ohio, and the necessary resources invested to put Frigidaires into mass production. So, having developed as a hub for automobile production, Detroit also became something of a cradle of refrigerator production and the first place where mechanical refrigerators were adopted in significant numbers; estimates made by utility companies in 1921 put the number of refrigerators in household use at around 50 in Philadelphia, 150 in New York, 200 in Boston but an astonishing 2500 in Detroit (Matly 2005, p. 34).

General Electric made its first foray into refrigeration in 1911 at its works in Fort Wayne, Indiana, where it manufactured Audiffren-Singrün sulphur dioxide compression machines, developed by the Cistercian monk and physicist, Marcel Audiffren, for cooling wine (Cowan 1985a; Radermacher & Kim 1996, p. 61). This design was not suitable for home use but in 1917 General Electric’s President, Gerard Swope, actively pushed the company towards the consumer appliance market as a strategy to aid recovery in the post First World War period. General Electric began investigating modified designs for domestic use and the report that Swope commissioned to assess current refrigerator production and potential markets recommended that the company invest in developing air cooling technology (Cowan 1985a). Water-cooled models had the disadvantage that they required a permanent connection to a water supply. A move away from water cooling would benefit consumers by removing the cost of having a water connection specially installed and paying water rates; mostly, though, it would benefit General Electric in terms of increased electricity consumption. Air-cooled models were being produced by 1924 and the following year the company launched the famous ‘Monitor Top’ (similar in appearance to the refrigerator shown in Figure 3.3, above), a fully contained unit with the mechanism built into the cabinet. With a vast investment of $18 million in a new production plant, the Monitor Top went into mass production in 1926.

The last of the four principal domestic refrigerator manufacturers used a different cooling system for its domestic refrigerators. It was also the first to develop outside of the United States, this time in Sweden, where it exerted a much more significant influence on European than American markets. In 1922, two engineering students the Royal Institute of Technology in Stockholm, Baltzar von Platen and Carl Munters, drew upon Ferdinand Carré's 1857 design to develop an absorption refrigerator. This used a heat source such as gas, electricity or kerosene to create cold. Once common in industry, few ammonia absorption systems remained in use after the First World War, but this design would shortly be widely adopted for domestic use. Platen and Munters set up AB Arctic and Platen-Munters Refrigeration System and began small-scale production in Motala, Sweden, in 1923. Their work caught the attention of Axel Wenner-Gren, Chairman of Electrolux, who bought the company in 1925 and shortly thereafter Electrolux made the move into refrigeration production (Sayres 1928; Cooper 1997, p. 74).

Few British households could afford the earliest refrigerators and, like iceboxes, these became widespread in commercial premises, hotels and restaurants long before they made their way into ordinary homes. The first mechanical refrigerators in Britain were shipped from the United States and during the 1920s Frigidaire, Kelvinator and General Electric machines were imported. The Electrolux refrigerator was unveiled to the British trade and press at the Savoy Hotel in London in February 1926 (Cooper 1997, p.74). The following year, Electrolux began manufacturing vacuum cleaners and domestic refrigerators in Britain, at a plant in Luton. One of the earliest Electrolux units manufactured in Britain was owned by HM King George V (Figure 3.9) and later this 'Royal fridge' went into retirement at the Science Museum, where it now forms part of the domestic technology collection (*Eastern Evening News* 1966). More accessible models began appearing from 1929 when Electrolux brought out a smaller 4 cu ft fridge and soon afterwards built-in refrigerators were introduced, which became popular in the modern flats being constructed at the time. Ownership increased as the size of cabinets, and hence the price, decreased, and in 1932 very compact 1 cu ft models became widely available (DoRDeC 1957b, p. 5). That same year Frigidaire determined that demand was sufficiently high to start manufacturing domestic units in Britain rather than transporting them from the United States.

Figure 3.9 Electrolux Refrigerator, formerly owned by King George V, now part of the Science Museum's domestic technology collection

Source: own photograph

Peter Jacomelli (FFSS) remembered his father buying one of the earlier Frigidaires in 1928 to replace the icebox in the family's restaurant and he recalled that this "wonderful thing" ran efficiently for over thirty years. Norman Robson (FFSS) also had vivid childhood memories of the arrival of a refrigerator purchased for his uncle's grocery store:

> I well remember the great day. I suppose I must have been six or seven so it was getting on for 1930, I guess, when my uncle bought the first fridge. This was a massive investment, very new, only the best grocers had got a fridge. … It was an enormous big box which occupied half of his stockroom at the back.

The decision about whether the family could afford such a costly purchase had been a major one but Robson recalled how the move from cooling with ice to cooling with electricity was a hugely important step in modernising the family business, for the ability to hold stock for longer transformed the way his uncle was able to operate. Eventually, these mechanical refrigerators would make ice companies obsolete, but at the outset success did not seem so certain.

COMPETING KINDS OF COOLING

'Mechanicals' versus ice

Ice boxes and refrigerators coexisted for some decades from the 1920s and ice deliveries in larger towns and cities by companies like Gatti continued up until the Second World War, first by horse and cart and then by van (Figure 3.10).

Figure 3.10 Carlo Gatti ice delivery cart

© Canal Museum Trust, used with permission of the London Canal Museum

Principal consumers would have been butchers, fishmongers, restaurants and hotels. One of the businesses on Gatti's delivery route was the restaurant run by fellow Swiss-Italians, the Jacomelli family. In an interview, Peter Jacomelli described the daily deliveries of meat, vegetables, churns of milk and blocks of ice and emphasised that ice would have been a normal overhead for restaurants at that time. He had memories from his very early childhood in the 1920s of the huge wooden icebox, a cabinet about two metres wide and a metre deep with separate compartments for storing fish and for hanging meat, which was restocked daily with enormous blocks of ice. Bill Pickering reminisced about growing up in the 1930s and watching trucks in Norton high street unload the ice they brought the thirty miles or so from Hull each day:

> The first stop always seemed to be Freers Butchers where the huge blocks were dragged from the lorry on to the road, being manhandled by the driver using a pair of iron tongs, and slid across the road and pavement into the shop. This was the butchers' only way of keeping meat fresh in those days, so the ice-man was a vital part of the system. … My father's shop, Central Stores, … also sold ice cream and the block for freezing went down into the cellar below, through a trap door in the pavement (Pickering 2001).

Shipments of Norwegian ice were regularly landed in Hull, until these were superseded by its ice plant. From the turn of the century, ice was increasingly an industrialised product, no longer harvested but manufactured. Ralph Raimi raises a fascinating example of the slippage that can occur when knowledges get tangled and fail to keep pace evenly with such changes in technology. He reminisced about how he and other children used to gather excitedly when the iceman came by, hoping to pick up chips of ice to suck on. Raimi said:

> Our parents always cautioned us not to do this, because the ice "was made with ammonia," and therefore presumably poisonous. This was false and we knew it. … I conjecture the ammonia story arose from the time that ice began to be manufactured, rather than cut from the river in the winter. … At any rate, the manufacture of ice was more common by the time I was growing up, though still new in the time-scale our parents lived by, and they were suspicious of the process, as they were of all such technology. Electric refrigeration requires a refrigerant fluid, and it might well have involved ammonia in 1930; I don't know. But I am sure my parents confused the idea of a refrigeration fluid used to make ice with the idea of an additive to the ice itself (Raimi 1998).

While some were wary about this new way of making ice, even more were hesitant initially about the introduction of an alternative to ice use altogether. Edmund Copeland emphasised how challenging it was for mechanical refrigeration to gain a foothold in the market in its early years. Companies were faced with recruiting customers to a new and as yet unproven technology, whilst also confronting opposition from ice traders. Despite his seven years as

President of Kelvinator, Copeland never profited from refrigeration personally, but his colleagues commended his determination in laying the foundation for household refrigeration; he was, they believed, "the man who established the industry. … If it were not for his stick-to-it-iveness we might not have electric refrigeration today" (cited in Cooper 1997, p. 77). The refrigerator posed little threat at first. It was an unfamiliar and often unreliable technology, which came complete with flammable refrigerants and a prohibitive price tag. Practical infrastructural constraints and space limitations in many kitchens also made fridges slow to catch on, for these were bulky appliances which needed either electrical connections or a gas supply. Where the mechanical refrigeration industry proved to have real strengths was in the effectiveness of its marketing. It was quick to promote the idea that the problems with irregular ice delivery, poor customer service and long-standing confusion about the appropriate amount of ice to use could be easily resolved by purchasing a mechanical refrigerator.

In the United States, the National Association of Ice Industries' (NAII) preoccupation with industrial ice use and rail car supply prevented it from recognising the potential for consumption on a domestic scale. Household use was only something it began actively promoting in 1923, in response to competition it was already experiencing from mechanical refrigerators. Resolving to undertake a national promotional strategy to increase icebox ownership, the NAII hired Mary Engle Pennington to create a Household Refrigeration Bureau and took on female home service workers. Pennington trained staff so that they could visit customers and give instruction as part of an attempt to improve outreach and education. However, promotional campaigns for mechanical refrigerators played very effectively upon the problems of poor quality iceboxes and Pennington's own research showed many iceboxes to be neither well designed nor well insulated and consequently unable to maintain sufficiently low temperatures.

1926 was the year when 'mechanicals' really began to bite. Breedlove likened their effect to "a pair of scissors, both edges of which are cutting" (1932, p. 243). Wealthy customers were the first to be lured from ice to mechanical cooling and although ice companies were reasonably successful in recruiting new users, these came in the shape of smaller and less profitable working-class consumers. The marketing of mechanicals began before they were particularly reliable, but by the early 1930s their quality was much improved and prices had fallen. Robinson (1999) suggests that by the mid 1930s an electric refrigerator was no more expensive to buy and run than a good quality icebox. Many considered the industry short-sighted for not using mass production methods to bring down the unit cost for iceboxes in the way that mechanical refrigerator manufacturers were doing (Robinson 1999, p. 256).[44] Writing in 1932, when one in three homes had been wired for electricity (as I discuss more fully in the next section), Breedlove sensed an inevitability about the dominance of refrigerators and decline of ice: "all indications point to the fact that the average housewife wants the automatic refrigerator and will buy it as soon as the family budget will permit" (1932, p. 241). It was a case of *when*, not *if*.

Campaigns promoting mechanical refrigerators prompted a reciprocal flurry of anti-refrigerator promotion on the part of ice companies; "the industry rushed out to tell everyone that the household mechanical refrigerator was not a success in comparison with the ice refrigerator. But soon it was evident that the housewife did not believe the story" (Breedlove 1932, p. 237). The industry's only hope, he felt, was to keep the cost of iceboxes and ice supply sufficiently below the cost of mechanical refrigeration that the housewife found it worth her while to put up with the inconvenience (1932, p. 241). Refrigerator manufacturers were busy selling 'convenience' as much as they were selling a machine, and this included freedom from the routine of daily ice deliveries. Consumer demand had already forced icemen to complete household deliveries in the mornings "to relieve the ladies of household bondage" as they waited for their cold to arrive by van and to be carried bodily into the kitchen (Breedlove 1932, p. 242). Ice delivery was heavy physical work. It was a virtually all-male industry, heavily reliant on unskilled and often immigrant labour. Robinson (1999) describes anxieties about middle-class white women being exposed to these differently raced, classed and gendered bodies in their homes. Investing in a refrigerating machine offered a way to avoid this sort of troubling proximity, and in so doing the refrigerator doubled as a kind of strategic social buffer.

44 Breedlove recounts the story of an ice company representative setting icebox manufacturers the challenge of producing a reliable icebox for less than ten dollars. "The proposition was declared impossible and the accompanying remarks pointedly referred to that official's mental deficiencies," while a company in a different field gladly met the challenge (Breedlove 1932, p. 241).

Pennington's publications, such as *Why We Refrigerate Foods* (1926), *Buying a Refrigerator* (1930), *Care of the Home Refrigerator* (1924) and *Journeys with Refrigerated Foods: Eggs* (1928), were successful in widening public understanding of food refrigeration, but the industry's real difficulty lay in adequately differentiating their product and promoting the specific benefits of refrigerating with ice, hence Breedlove's concern that "to date the benefits have fallen largely into the laps of the mechanical unit salesmen" (1932, p. 240). Between 1929 and 1935 business almost halved while mechanical refrigerator sales doubled. Ice companies had made strategic errors by failing to take either their domestic markets or the threat from mechanical refrigerators sufficiently seriously until too late. An editorial in *Ice and Refrigeration* in 1930 had confidently asserted that "an ample supply of new customers for ice" would continue and that ice would always remain cheaper than mechanical refrigeration (Ice and Refrigeration 1930, p. 307-8, cited in Robinson 1999, p. 268). The following year icebox sales fell into decline, never to recover.

Gas versus electricity

Electricity may have dominated lighting, but gas and solid fuel competed for other household functions and, in the mid 1930s, the question of whether gas or electricity would dominate domestic cooling was far from settled. An article discussing "Electrical Refrigeration Prospects," published in the *Electrical Review* in early 1936, alerted readers in Britain's electrical industry to an unexpected surge in the popularity of gas refrigerators (Quarmby 1936). The previous summer, gas refrigerator manufacturers had mounted a bold and highly successful nine-week campaign in the south of England during which over 7,500 gas refrigerators were sold. Such figures are remarkable, given the low levels of gas refrigerator use and the absence of any concerted marketing policy on the part of the gas industry up until then. Exhibiting a high degree of coordination, the industry set up a National Council to act as a centralised buying and supply agency. The council approached a major manufacturer, which I take to be Electrolux, then manufacturing 40,000 gas and electric cabinets per year, and struck a deal whereby it committed to buy Electrolux's entire output for a five-year period on condition that the company ceased production of electric refrigerators altogether.[45] This predatory move brought about the deliberate suppression of electric models by one of Britain's leading refrigerator producers in the hope it might create a knock-on effect, with purchasers of gas refrigerators more likely to purchase other gas appliances as well. Refrigerators were positioned here as entry points into the home upon which other appliances might piggyback, hence Quarmby's worry that this might not only compromise refrigerator sales but also "keep the electric cooker out of the house for many years" (1936, p. 170).

Astonished by the gas industry's imagination and audacity, Quarmby commented on the differences in attitude and approach between the two utilities:

> I find it difficult at this stage to try to imagine any electricity supply authority of my acquaintance considering seriously the possibility of being able to dispose of anything like this quantity of electrical refrigerators in one season, or of having the courage to think it possible, in spite of the fact that in many cases they have many more times the number of consumers (1936, p. 170).

He urged swift action, convinced that the domestic refrigerator "rightly belongs to the electrical industry," and fearing that the industry's investment in promoting electrical refrigeration and its hard work educating the public over the previous ten years were now under serious threat. His recommendation was, firstly, that prices must be made attractive and finance more accessible and advised electricity companies to match the hire-purchase schemes offered on easy terms by gas companies: five years interest free, with just a small initial deposit. Even though it took manufacturers longer to recoup their investment, it made it much easier for new customers to enter the appliance market. Having elected to go either gas or electric, this was not something that people would change lightly, hence each industry's objective was "to prevent the installation of any other type, as when once installed the domestic cabinet usually becomes a permanent fixture for a long period" (1936, p. 170). A replacement market was beginning to emerge for the first generation of refrigerators. As the average lifetime of appliances was much longer than those in use today, replacement opportunities were correspondingly slow to come round again. There was also a need for

45 Although the article does not the name Electrolux, my research indicates that it was the company in question. Electrolux was a major manufacturer in Britain at this time and one of the few to produce both gas and electric models on this scale. There are repeated references in the trade literature to Electrolux deciding to go 'all-gas' around this time, with little explanation as to why. The attraction of a secure five-year marketing deal provides a convincing explanation for it doing so.

improved service periods and longer guarantees. Confident about the reliability of their product, gas manufacturers were offering five-year guarantees and free repairs whereas electrical manufactures offered four at most, and some smaller companies just one. Absorption refrigerators were heavily promoted on the basis that they had no moving parts and, as a consequence, less risk of breakdown. Electric manufacturers were better placed to claim that their product offered ease of installation. With power sockets increasingly common in the kitchen, refrigerators could simply be plugged straight in whereas gas appliances required a gas connection to be specially installed. As for running costs, both sides regularly laid claim to being cheaper and more efficient.

Despite Quarmby's alarm, reports about the health of the electric refrigeration industry in the *Electrical Review* later in the year sounded fairly optimistic. Hire-purchase schemes similar the one offered in the gas campaign the previous year were already underway in Ealing and West Ham and soon to be launched in other parts of London, nine new firms had entered the refrigerator market and almost all companies reported an increase in sales upon the previous year (*Electrical Review* 1936, p. 568-70). It appeared that the electrical industry had taken note and stepped up its promotional activity, though it was also acknowledged that the gas industry's home refrigeration campaign may actually have benefitted electrical refrigeration too. Just like the earlier battle between 'mechanicals' and ice, the challenge was much more complex than promoting the benefits of refrigeration in general and involved carefully delineating the merits of a particular kind of refrigeration and convincing prospective customers that one type would better suit their needs better than another.

Nevertheless, the article supported Quarmby's argument that the electrical industry would be wise to develop a more comprehensive marketing strategy and secure stronger backing from the electricity supply authorities. *All* the links along the 'chain' of the electricity industry, he emphasised, from supply companies, power producers and contractors to appliance manufacturers, distributors and organisations like the Electrical Development Association (EDA), needed to work to together to communicate a common message. He suggested electric companies learn from the gas campaign by increasing national advertising, providing specialised training for showroom staff and sales staff, improving window displays and giving product demonstrations. Ultimately, the electrical industry did dominate the market, which is why we have the kinds of refrigerators we do today. This outcome was never predetermined and what is considered 'normal' today could potentially have been quite different. Gas powered refrigerators are still available, though rare, mostly being used for mobile applications such as boats, caravans and recreational vehicles. In Cowan's account of "how the refrigerator got its hum," she asks why our houses and kitchens are constructed in particular ways, and not in others, and examines why refrigerators powered by electric motors succeeded and silent gas-powered models 'failed' (Cowan 1985a). Her conclusion is blunt:

> We have compression, rather than absorption, refrigerators … today not because one was technically better than the other and not even because consumers preferred one machine … over the other, but because General Electric, General Motors, Kelvinator, and Westinghouse were very large, very powerful, very aggressive, and very resourceful companies, while Servel and SORCO were not (1985a, p. 215).

This may also be why seemingly incongruous appliances like cooker-refrigerator combos never took off. The appliance sitting on a pallet in the Science Museum store, which at first glance looks like a conventional gas cooker, opens to reveal a refrigerator – not an oven – underneath the hob (Figures 3.11 & 3.12).

Figures 3.11 & 3.12 Combination gas stove and refrigerator

Source: own photographs

A refrigerator-oven can be a startling discovery if it is not something we would expect to see. The combination of a 'hot' and 'cold' appliance might appear counter-intuitive but, because absorption refrigeration requires a source of heat to operate, combining these two gas appliances is entirely logical, *if* one understands the principles of absorption cooling. This reminds us that there is nothing inevitable about how our technologies look or work.

Here we see an example of a design alternative that was perfectly possible technically, and evidently available on the market for a time, but, for one reason or another, was ultimately a path not taken. A variety of factors economic, technical and political meant few such appliances made their way into British homes. Even the once-common Electrolux gas fridge was supplanted by electric powered compression models. And so it is that Maggie Brogan makes passing reference to an advertisement from the 1940s "for the paradoxically named Electrolux gas refrigerator" (1997, p. 36). Arguably, there is little paradoxical about it, *unless* you did not know that refrigerators were ever powered by gas. The very existence of such technology is, it seems, no longer common knowledge, now that electric refrigeration is unquestioningly the norm.

SPREADING THE ELECTRICAL MESSAGE

Electricity production in Britain more than doubled during the First World War and there was a clear expectation that this would be an increasingly important source of power in the country's postwar industrial recovery. A process of rationalising electricity generation across the country was initiated with the 1919 Electricity (Supply) Act and, in 1925, the Weir Committee Report proposed that a 'National Grid' be established. The government set up a Central Electricity Board to oversee electricity production and to carry out the long and costly task of frequency standardisation necessary to link multiple regional systems into a national network. Electricity pylons carrying high-tension transmission lines began their march across the landscape to link power stations together in a grid that extended over most of Britain by the mid 1930s.

Building load, one appliance at a time

Utility companies faced the challenge of trying to balance generating capacity with energy demand. For efficiency, companies aim to operate at or close to capacity but electricity cannot be stored. As a highly 'perishable' commodity, it must be used when generated or else wasted. The Electrical Development Association (EDA) was set up in 1919 as a subgroup of the Institute of Electrical Engineers Heating and Cooking Committee. Acting as a kind of public relations wing of the electricity industry, among the aims explicitly listed in its Articles of Association were to promote the electrical industry and "to further and develop the use of and demand for electrical energy … as an end in itself, and as a means for increasing the demand for electrical apparatus" (Osborn 1946, p. 398). The core of the organisations' rationale was, therefore, to build load by encouraging businesses and individuals to consume electricity more liberally.

The EDA worked mostly with industry, local authorities, housebuilders and professional bodies but the organisation also claimed that "the domestic application of electricity has always taken a large place in EDA's activities, and housewives are constantly being advised how this great public service can lighten their burdens" (Osborn 1946, p. 399). As a whole, the electrical industry was slow to recognise the potential for domestic electricity consumption and it was only with a period of economic downturn that it began viewing domestic users as an underexploited market. Domestic electricity consumption rose as the proportion of houses connected to the network increased, from 12% in 1921 to one third by 1931 and two thirds by 1938 (Bowden & Offner 1996, p. 250). Financial incentives such as subsidies and deferred payments encouraged many people to get their homes wired, but being wired for electricity often translated into using it just for lighting, and maybe ironing. With domestic electricity being used principally for lighting, peak demand obviously came in the evenings. Utilities therefore sought ways to increase daytime consumption by taking upon themselves "the unfamiliar task of encouraging the adoption and use of new domestic technologies," and some, like General Electric and Westinghouse, purchased small appliance companies as a way to enter the domestic market (Williams 1998, p. 95).

The first electrical appliances introduced onto the domestic market were the electric iron in the opening decade of the twentieth century, followed by the vacuum cleaner four or five years later and clothes washers and water heaters in the early 1920s (Bowden & Offner 1996, p. 247). Small appliances, such as irons, kettles and radios, were the most affordable and also offered the advantage of being able to plug directly into a light fitting without the kind of alterations like installing wiring, sockets or additional water connections that many larger appliances demanded. Matly estimates that there were about 3000 or so refrigerators in all across the United States in 1921; just two years later he puts the number at closer to 20,000 (2005, p. 34). By 1936, over two million were being sold a year. In Britain, on the other hand, the adoption of electrical appliances "lagged almost a generation behind" (Bowden & Offner 1996, p. 245). One factor was the speed of domestic electrification. In Europe, this was a state-organised process, whereas it was driven by the private sector in the United States and progressed much more rapidly (at least in urban areas, though rural areas, judged to be unprofitable, were often twenty to thirty years behind) (Matly 2005, p. 5). Availability of and attitudes towards consumer credit were another factor. Matly suggests that as many as 80% of appliances were bought on credit in the United States (2005, p. 35). British culture, in contrast, displayed a stronger moral economy of thrift. For the working-class women interviewed by Giles (1995), thrift was associated with good household management and feminine identity, while debt was viewed as irresponsible. Hire-purchase was not uncommon, but, at least in the 1930s, it was "always considered to be a 'not quite nice' way of financing one's purchase and it was never talked about" (O'Connell 2005). Only in the 1950s, with the relaxation of government restrictions, did it become more widespread.

Purchase price, installation costs, ongoing running costs, access to financing and the matter of whether electricity was already available in the house were all factors affecting the adoption of appliances. Roberts suggests that prior to 1940 very few people in Britain actually owned electrical appliances, with the possible exception of an electric iron (1989, p. 106). But, even though buying appliances was out of reach for many, people could rent directly from utility companies, who endeavoured to keep rental rates affordable as such rentals represented a good way for them to sell load. As a result, even working-class homes could often afford to rent at least one appliance (Bowden & Offner 1996, p. 251). A brief handwritten note on the back of a photograph in the Electricity Council archive at the Museum of Science and Industry in

Manchester refers to a Brigadier General Wade-Hayes, formerly the Managing Director of Edmondsons electrical store in Wimbledon. Apparently, the policy there in the 1930s was to lend appliances to consumers; they did not bother to hire them out as they got their 'money back' through the cost of electricity supplied.

The EDA was invested in altering public perceptions of electrical appliances in order to facilitate their shift from the category of 'luxury' to 'necessity.' This meant convincing consumers that electrical appliances were things they could and should have. Beginning with initiatives to encourage householders to introduce electric light and power to their homes, the EDA went on to run campaigns on electric cooking, water-heating and refrigeration. Promotional strategies included the provision of consumer information and advice through books and pamphlets; giving lectures to community organisations, trade associations and schools; and screening films in schools, community halls and cinemas. In addition, the EDA organised exhibitions, which in the 1940s increasingly gravitated towards the theme of kitchen planning, and ran competitions, with awards for architects judged to have designed the best electric kitchens. Above all, the EDA considered media advertising to be its most effective tool and extensive advertising campaigns in the trade and popular presses reached a wide but primarily middle-class readership through national daily newspapers such as the *Daily Mail*, *Daily Express* and *Financial Times* and women's weeklies like *Good Housekeeping*, *Ideal Home* and *Home & Garden* (Bowden & Offner 1996, p. 265-6). Although two third of homes had electric lighting by the end of the 1930s, few working-class households could afford the cost of electricity for domestic heating or multiple appliances, meaning that most homes continued to be, as Hannah (1979, p. 208) puts it, "machine[s] heated by coal, coke and gas and powered by women."

Gendering electricity

Matly argues that the gendering of electrification in Europe and the United States was quite different. He characterises Europe as using an 'all male' model whereas in the United States women had greater participation in the process and recognition of the potential connections between women's work and electricity supply came much earlier (2005, p. 6). In their study of diffusion rates of appliances in Britain, Bowden & Offner make an important distinction between electrical appliances associated with housework and those connected with leisure, observing that those with the least gendered pattern of consumption, such as lighting or radio, were the first to become established in British homes. Less than 1% of households had a radio in 1922 but it took just ten years for the radio to reach 50% of households, whereas irons and refrigerators took over twenty years to do so (Bowden & Offner 1996, p. 247). They interpret the popularity of leisure-related 'time using' devices over the 'time saving' devices associated with women's work as an expression of the low value placed on women's time (1996, p. 247, 259). A significant class dimension also applied to take-up rates. Unsurprisingly, ownership was skewed towards upper- and middle-class households. Not only did working-class women lack the financial means to purchase appliances but, with their own labour assigned low value, making a substantial investment in an appliance designed to 'save' it did not make economic sense (1996, p. 250). Nevertheless, there is a slight twist to the question of class-related appliance use. Appliances owned by middle-class women were often not used by them personally but by the working-class women employed as servants in their homes (1996, p. 268-9). Rather larger numbers of working-class women may technically have been users of electrical appliances, therefore, but in their workplaces rather than their own homes.

Utilities used a range of strategies to recruit new appliance users and enrol new households into energy distribution networks. In addition to advertising, marketing and financing arrangements, many companies sent salesmen directly into peoples homes. At the outset, domestic appliances sales teams were exclusively male, in keeping with the dominantly masculine composition of the energy industries. However, salesmen were not always effective in selling to women as they brought with them a rather patchy understanding of how domestic appliances were actually used. Lacking first-hand experience of those practices with which their products were connected, "their misconceptions about what women actually did and how they functioned inside the home made the utility businessmen ignorant and ineffective in promoting complex electric tools such as ranges and other cooking devices that entailed dramatic changes in household practices." Most appliances do not perform a single isolated function so much as fit into a complex 'suite of practices' and salesmen struggled to introduce them "into the intricacies of a food-preparation system they hardly understood" (Williams 1998, p.95-7, 104).

There was a knowledge gap. These men, skilled as they may have been in technical understanding or in salesmanship, simply did not have the requisite domestic knowledges, either theoretical or applied, to understand how their products would and could re-shape domestic practices in the home. They struggled to recognise either the potential these appliances offered, or the problems that they posed. It was only when the British electrical industry developed a better understanding of women's roles as users and consumers of electrical technologies that the industry achieved more success in marketing these machines to them. This was achieved in part by bringing women onto the sales teams. Utilities started recruiting women as Demonstrators and Williams (1998) describes these positions fulfilling a role as 'surrogate female elders,' older and more experienced women from whom others learnt housecraft skills. It was an awkward role for men to try to assume; they not only lacked the appropriate knowledge and experience but women were also unfamiliar with looking to them for the transmission of domestic knowledges. A strict gender divide was thereby created in which men were salesmen and women demonstrators. Men were responsible for the technical and business aspects. They were the ones who explained how the machines worked, while women explained how the *users* should work by giving practical instruction on how to use the appliances in day to day life. Thus, accompanying the gendered division of labour was a parallel gendered division of knowledge.

British women did not feature prominently in the process of electrification until the 1940s, when they were identified as a potential market for appliances, and it was to them that marketing was increasingly directed after the Second World War when "women, and no longer men, [were] considered by industry to be the vectors of modernity" (Matly 2005, p. 30). Guidance from a 1955 EDA Salesmanship course outlined the grounds on which domestic refrigeration should be promoted. Listed alongside the benefits of health, efficiency, economy and leisure was the "desire for modernity." The handbook explained that:

> the very fact that a refrigerator is considered a luxury contributes to its prestige value for the consumer whose desire for the latest thing is inspired by a wish to equal or outshine her neighbours. … For all kinds of people refrigeration provides the newest way of storing and preserving food, and the most recent innovation in ways of serving (EDA 1955, p. 40).

A refrigerator was a way to make a woman modern. However, in order to feel better equipped to participate in a version of modernity that was increasingly predicated upon electrical technologies and practices, women identified a need for a separate electrical organisation, one targeted specifically to their own needs and interests.

The Electrical Association for Women

The Electrical Association for Women (EAW) emerged out of Mabel Matthews' attempts to persuade the Institution of Electrical Engineers (IEE) to create a women's organisation focused on electrical issues (Matthews 1924; also see Randell 1945 and Symons 1993). Having failed to interest either the IEE or EDA, in 1924 she approached the Women's Engineering Society (WES) who set up a Women's Electrical Committee until the EAW was launched as an independent organisation in November of that year. Caroline Haslett, Secretary of WES, was brought on board as Director and her approaches to the EDA met with rather more success than Matthews' for it became the EAW's main supporter and funder thereafter. Of the EAW Council's twenty four members, three were men, including the Director of the EDA. The EAW recognised that, although an organisation for women, cooperation with men and male-dominated organisations was both necessary and unavoidable given that "men produced the electricity, distributed it, invented the appliances and put it to work and controlled all the agencies, public and private, that dealt with it" (Pursell 1999, p. 49).

The EAW was initially set up to encourage more women to go into electrical engineering. Llewelyn Atkinson, one of the founder members, noted that at the outset "what has since become the important function of the Electrical Association for Women was scarcely noticed. It was Miss Haslett who caught the idea of the domestic women's need and developed it" (Scott 1934, p. 4-5). The domestic had certainly been implicit in the association's origins, indeed the topic of Mabel Matthews' presentation to the WES in June 1924 was "On a scheme for popularizing the domestic use of electricity," but the organisation's explicit focus on *domestic* electricity emerged only later. Nevertheless, in Haslett's vision, the EAW was far more than simply part of the electrical industry; it was an organisation concerned with women's well-being in general (Scott 1934, p. 1). Its remit was educational. It aimed "to give knowledge of the wider uses of electricity in modern life," both to better equip those women in the industry and to benefit of the nation's housewives (Osborn 1946, p. 417). This involved "educating housewives about the characteristics, virtues and possibilities of electrical housekeeping; educating young women for careers as appliance demonstrators, domestic science teachers or electrical housewifery; educating the industry about the needs and desires of domestic consumers," and also representing women's voices on government committees (Pursell 1999, p. 51-2). In short, the EAW's role involved teaching women about electricity but also, crucially, teaching the electrical industry about women and, on the occasion of the organisation's fortieth anniversary, members elected to celebrate these interwoven facets of their work though the indubitably domestic medium of the tea towel (Figure 3.13).

Figure 3.13 Electrical Association for Women Fortieth Anniversary tea towel, 1964

"The twin keys to women's earthly paradise were the Vote and Electricity," MP Ellen Wilkinson had boldly proclaimed when she was a suffrage worker (*Electrical Age for Women* 1934, p. 653, cited in Pursell 1999, p. 56). In 1918 women over thirty, and a decade later all women over twenty-one, gained the first; the EAW took on the task of delivering the second, and in some eyes the more important, of these keys. In Scott's words, a crucial role of the EAW was to convey information "locked up in the minds of engineers … in a simple form for women to understand," based on the belief that such knowledge could help "make women free in a way [that] … political enfranchisement could never free them" (Scott 1934, p. 4, 1). This suggests that having a voice was all very well, but having the time and energy to use that voice by minimising household drudgery was just as important, if not more so. Envisioned as a kind of knowledge gathering, translation and delivery service, the EAW endeavoured to communicate particular kinds of knowledge in particular ways, so as to broaden access to the benefits of electricity. Technical knowledges tended to be held primarily by men in abstract forms not readily accessible to non-experts. The EAW sought to convert those knowledges into languages and forms that women, the majority of whom had no specialist training in the industry, could grasp. This involved taking information, quite literally, into sites and spaces where women met, or delivering it directly into their homes in the shape of publications or practical demonstrations. Such knowledge, coupled with the tools and confidence to use it, was considered critical to women's freedom and self-determination.

In 1927, a demonstration Electrical Housecraft Kitchen and Laundry was set up at the EAW's London headquarters. The office also housed an Inquiry Bureau, which provided information, undertook surveys and campaigns and published a quarterly magazine, *The Electrical Age for Women*, though most of EAW's work was carried out through its regional branches (Pursell 1999, p. 52).[46] The branches organised regular meetings and field trips and uncovered a huge demand for evening lectures and practical demonstrations, particularly from women working as appliance demonstrators and domestic science teachers. Certificated training courses were

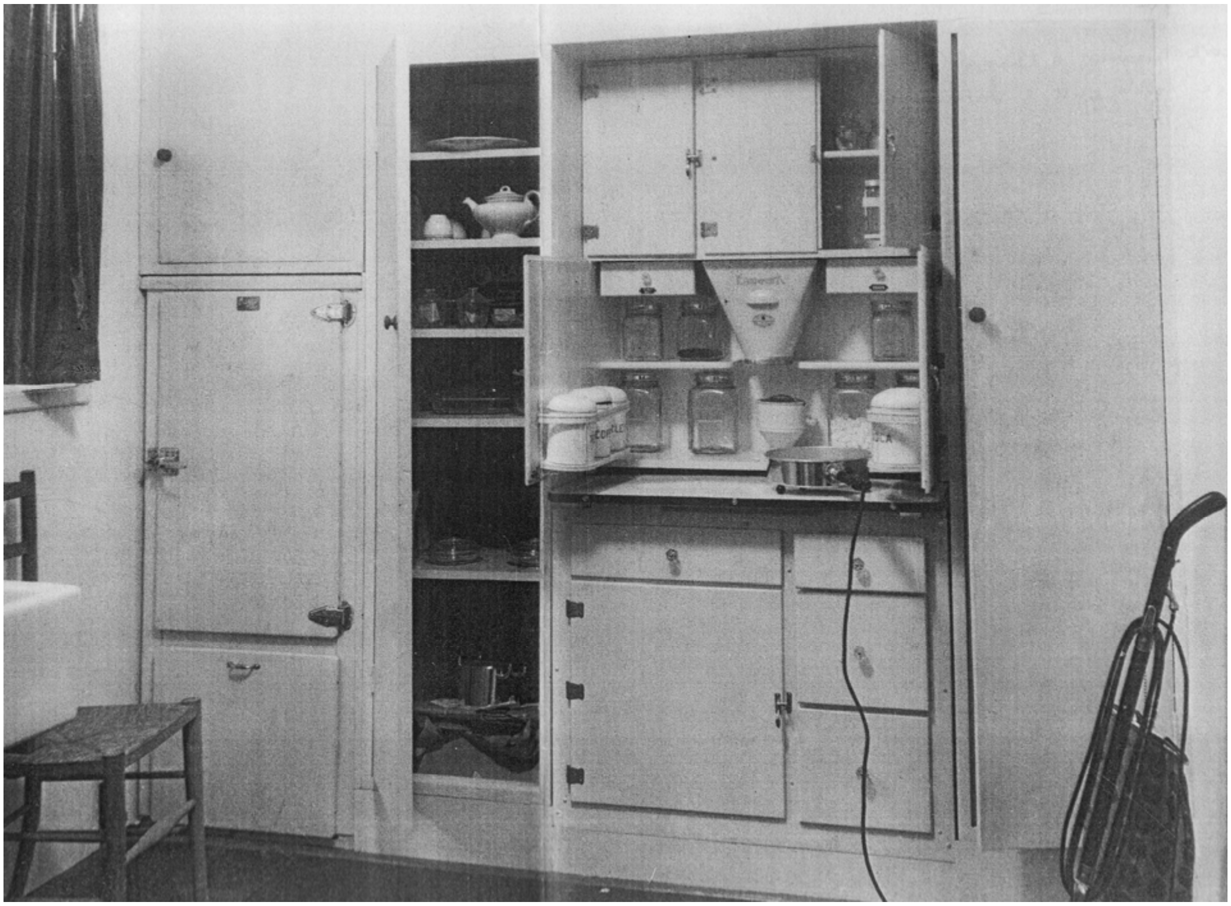
46 By the late 1930s the EAW had 80 branches, rising to 100 branches and a total membership of 10,000 women by the end of the 1940s. Membership increased through the 1960s to 262 branches in 1971 (Pursell 1990, p. 63). The organisation also developed international links and informal branches were set elsewhere in the world, such as the Netherlands, New Zealand and Trinidad and Tobago.

developed and towards the end of the 1920s colleges began offering programmes in 'Electrical Housecraft.' A certificate and diploma in 'Electrical Housecraft for Demonstrators, Saleswomen and Teachers' was set up in 1931, followed a few years later by a 'Home Worker's Certificate,' which offered practical and theoretical instruction on how to use and maintain electrical appliances. The organisation also did outreach work with women in rural areas, ran summer schools for teachers and developed textbooks, particularly directed towards girls, to help schools incorporate electrical education into the curriculum, usually though domestic science classes (Osborn 1946, p. 417). In this way, the EAW made use of both formal and informal education channels to transmit theoretical and practical electrical knowledges to women.

Housewives, bachelor girls and electrical exhibitions

Public exhibitions were a key channel through which the EAW communicated its message. In 1930, the organisation participated in the Bachelor Girls' Exhibition in London by sponsoring 'The Bachelor Girl's All-Electric Flat' designed by Edna Moseley, an architect and EAW member. The flat featured equipment such as an 'easywork dresser,' electric table grill, vacuum cleaner and, seen on the left hand side of the photograph, a built-in refrigerator (Figure 3.14).

Figure 3.14 Edna Moseley's 'Bachelor Girl's All-Electric Flat', 1930

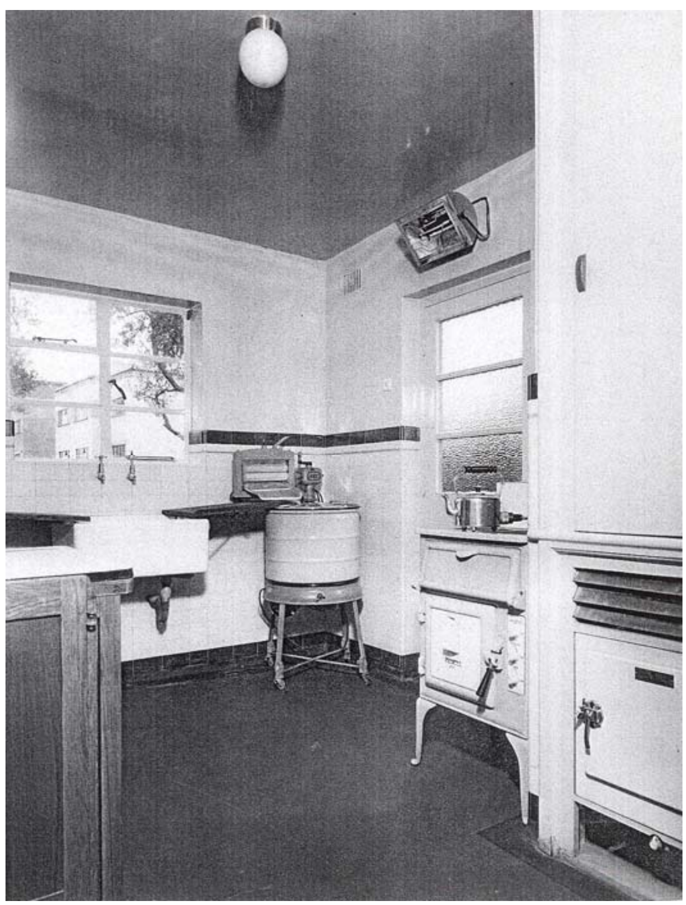


The concept of the 'bachelor girl,' a modern independent woman, emerged as an important counterpart to the 'housewife.' Access to electrical technologies was seen as one of the ingredients that granted her that independence. By performing domestic labours in her stead, appliances could grant her more flexibility within her home and also enhance her freedom from it. The skills but also the confidence to understand, use and maintain these appliances fed into the construction of a competent, capable and knowledgeable single woman. A woman blessed with an electric stove, refrigerator, washing machine and vacuum cleaner, so the argument went, was a woman less encumbered by the burdens of domesticity and more able to fulfil her potential as a citizen. Indirectly, therefore, refrigerators and the like were tools for self-actualisation.

This bachelor girl was a solidly middle-class figure and, despite an open membership in principle, most women involved in, or represented by, the EAW were disproportionately from middle-class, and some extremely wealthy, backgrounds. For the first decade of its existence, the EAW's focus was mainly on the homes and needs of this membership and scant attention was paid to working-class women. Branch activities were social as much as they were educational and included typically middle-class activities like bridge alongside more formal lecture programmes. Critiques suggest that, notwithstanding the liberatory rhetoric, lectures were not directed to working-class women and literature was circulated less widely than it could have been, appearing in women's weekly and monthly magazines that tended not to have a mass circulation (Bowden & Offner 1996, p. 268).

In the early 1930s, attention shifted somewhat and the organisation consciously attempted to broaden its scope to include working-class women. In 1932 the Voluntary Housing Societies of London staged an exhibition at Westminster for which the EAW created a model of an electrical working-class kitchen (Figure 3.15).

Figure 3.15 Electrical working-class kitchen, 1932



An EAW study carried out in 1934 revealed that fewer than half of working-class homes were wired for electricity (Edwards 1935). At that year's Annual General Meeting a motion was passed declaring that "the time has now come when Electricity should be available at an economic rate to the homes of the working people" (Pursell 1999, p. 55-6). However, while the intention was to make electricity accessible to working-class women by subsidising electricity connections and facilitating hire-purchase schemes, Bowden & Offner (1996) suggests that assistance remained limited in practice as EAW figures generally overestimated household budgets and underestimated the running costs of these appliances. Thus, the equipment featured in this image of a 1930s electrical kitchen, even one supposedly for a working-class home, still remained beyond the reach of most British households.

Innovation in the All-Electric House

One of the EAW's highest profile initiatives was the building of the 'All-Electric House' in Bristol (see Reece & Roberts 1998) (Figures 3.16 & 3.17). Designed by architect Adrian Powell, with a high degree of input from women in the organisation and beyond, this was a modern flat-roofed dwelling, fully equipped with electrical appliances, intended to be accessible to people of 'moderate income.'

Figure 3.16 The EAW's All-Electric House, Bristol, 1935

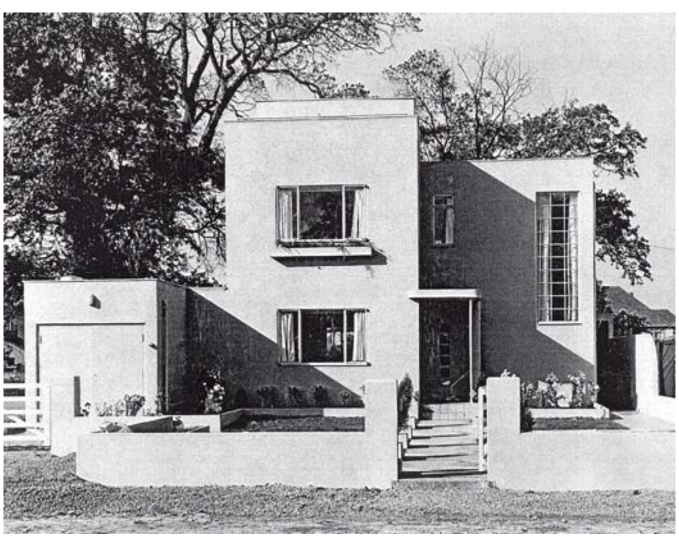
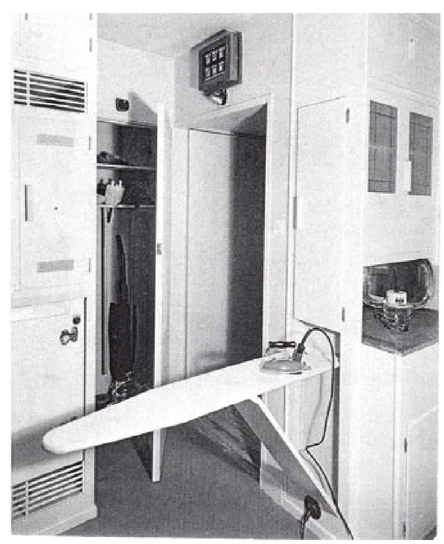


Figure 3.17 All-Electric House, interior



The house was opened to the public in October and November of 1935 during which time it attracted more than 20,000 visitors. Bristol's *Evening Post* described it as "'a marvel of modern conveniences,' … 'a house of women's dreams,' and devoted more than three pages to its glories – the automatically-lit pram cupboard, its labour-saving lack of fireplaces, and, wonder-of-wonders, a built-in refrigerator" (Morgan 1985, p. 18). The 2 cu ft built-in Electrolux refrigerator was prominently listed as a key feature in the promotional brochure and crops up repeatedly in the wealth of coverage that the house attracted. The All-Electric house was the subject of a spread in *Ideal Home* magazine in February 1936 and interest in its innovative features was such that it attracted media attention from around the world. In mid-1930s Britain, a fridge was still something that made news.

The first owners were Moss and Rita Garcia, who were given the house as a surprise wedding present by Rita's father. Moss described it as "a fabulous house that was beyond its time," emphasising that although features such as a refrigerator and built-in wardrobes with lights that came on automatically when the doors were opened might now seem unexceptional, they were "all unbelievably modern at the time" (Morgan 1985, p. 18). A *Bristol Evening Post* reporter revisited the EAW House fifty years on to find it in a neglected and dilapidated state. Once hailed as a 'vision of the future,' Morgan considered the house to be instead a fascinating "peephole to the past." She writes of visiting this 'time capsule,' peering through the window and being delighted to recognise the 50-year-old fridge she had just been reading about, an appliance once such a potent symbol of modernity before it faded from attention to become a rather ordinary household tool.

It was only a few months after its electric fridge went into the EAW All-Electric House that Electrolux made the decision to go 'all-gas,' triggering Quarmby's aforementioned anxiety about the threat posed by the gas industry. Discussion in the *Electrical Review* framed this period as a critical one for the refrigerator, believing it to be poised on the cusp of an explosion in ownership. Quarmby refers to 'experts' (though who these experts are remains unspecified) predicting the saturation of the domestic refrigeration market within ten years, and this at a time when only 5% of British households were estimated to have one. In the event, widespread adoption of refrigerators, electric or otherwise, took substantially longer than the ten years predicted. The diffusion of household appliances in general was rudely interrupted by the outbreak of war, during which time appliance manufacturing was suspended. Nevertheless, I argue that the Second World War brought about an important moment in the 'career' of the domestic refrigerator in Britain, one springing from a set of decisions about emergency postwar housing.

'PREFABS' AND POSTWAR HOUSING

The British government anticipated a serious housing shortage at the end of the Second World War and set up the Burt Committee to explore ways of housing the 'home-hungry' – returning soldiers, the large numbers of newly married couples and those whose houses had suffered war damage. The urgency with which this housing was needed, the shortages of materials and the huge drop in the labour force with building skills meant that relying on traditional construction methods would not be possible. Given the emergency situation, the government stepped in as a housing provider, an unusual occurrence in Britain where local rather than central government is responsible for housing, and the Ministry of Works formed a Directorate of Experimental Building Development to investigate non-traditional building materials and methods of prefabrication (Arcon 1948, p. 4).

In adopting prefabrication, Britain intentionally went out to import knowledges and manufacturing techniques from overseas. Precedents for prefabricated housing were rare in Britain so the government looked to Sweden, where a tradition of self-building allowed people without formal building skills to construct their own prefabricated homes, and to the United States, where factory production techniques had been applied to houses with some success.[47] An 'Expert Mission on Methods of Building in the USA' visited with a remit to examine building design, materials, construction methods and equipment (Osborn 1946, p. 519). The Mission's recommendation was that Britain adopt an American model of prefabrication using standardised components. The strategy was to produce houses on an assembly line in the factories that had been making arms and aircraft, thus shifting labour from the building site to the factory. Wiring, plumbing, water and gas pipes could all be preassembled, fittings installed

47 Prefabricated timber and iron buildings had been exported from Britain to its colonies during high levels of migration to Australia and New Zealand in the nineteenth century, but the application of prefabrication to houses was rare.

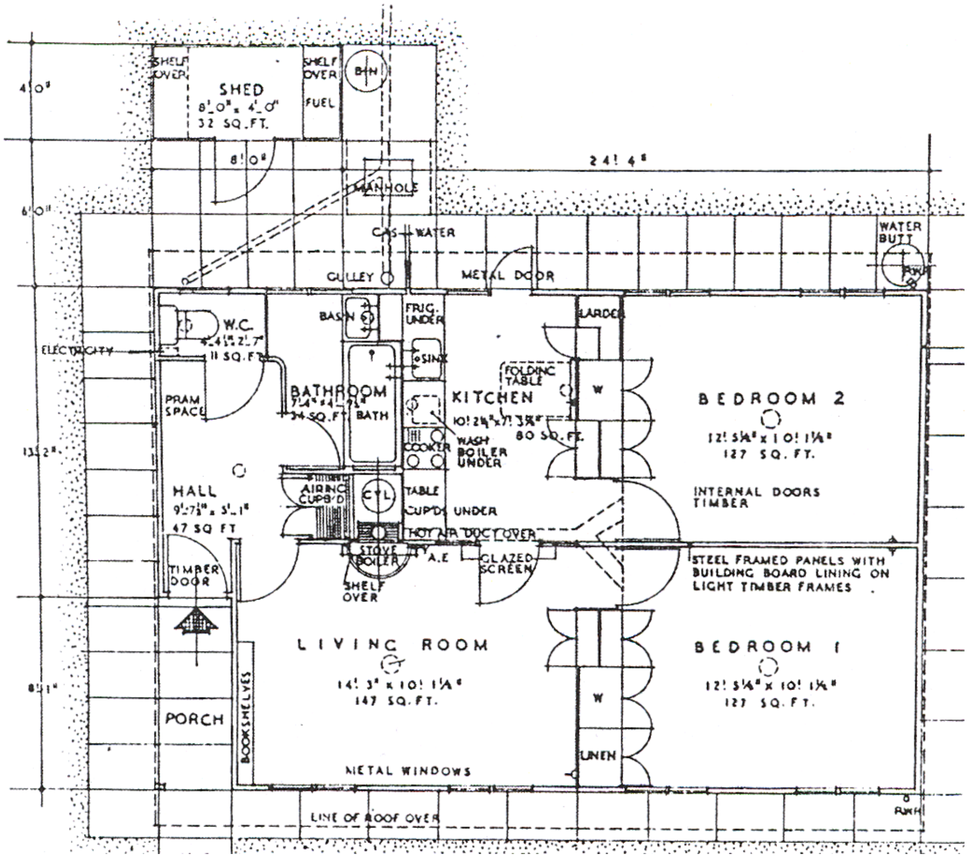
and finishes applied in the factory. The amount of skilled labour needed on site would be reduced as parts could be transported and erected using unskilled labour. This method of mass production originated from the meat trade's so-called *dis*assembly lines. As Henry Ford explained, "the idea came in a general way from the overhead trolley that the Chicago packers use in dressing beef" (Ford 1922, p. 81). William Klann, a foreman at Ford, described visiting the Chicago slaughterhouses, seeing "pigs on conveyors at Swift and Company" and figuring that "if they can kill pigs and cows that way, we can build cars that way" (Klann 1955, p. 22, cited by Heizer 1998, p. 97). Eventually, consumer durables and even houses came to be constructed that way as well.

The starting point for post-war housing was the 'Portal Emergency Bungalow,' an all-steel prototype designed by the Ministry of Works and named after the Minister, Lord Portal. The Portal was a rectangle of 616 square feet comprising an entrance hall, kitchen, sitting room, two bedrooms, a bathroom, toilet and shed (Figure 3.18). Forming the core of the bungalow, and constituting its most innovative feature, was the Kitchen/Bathroom Service Unit:

> The idea behind the Kitchen/Bathroom unit is simply to have the service fittings of the kitchen: sink, cooker, wash boiler and refrigerator – placed back to back with the service fittings of the bathroom: bath, lavatory-basin and water closet. The compact grouping makes it possible to incorporate all these fittings in one transportable unit (Arcon 1948, p. 4).

Vale describes the provision of a refrigerator in each prefab as "revolutionary" (1995, p. 114). They were certainly still unusual in Britain at the time, even if already common in the United States. Though modest by contemporary standards, and neither overly spacious nor particularly attractive, prefabs represented a major improvement for many working-class families and were known for the range and quality of their fittings.

Figure 3.18 Plan of the Portal Pressed Steel Bungalow



Source: Ministry of Health/Ministry of Works 1944

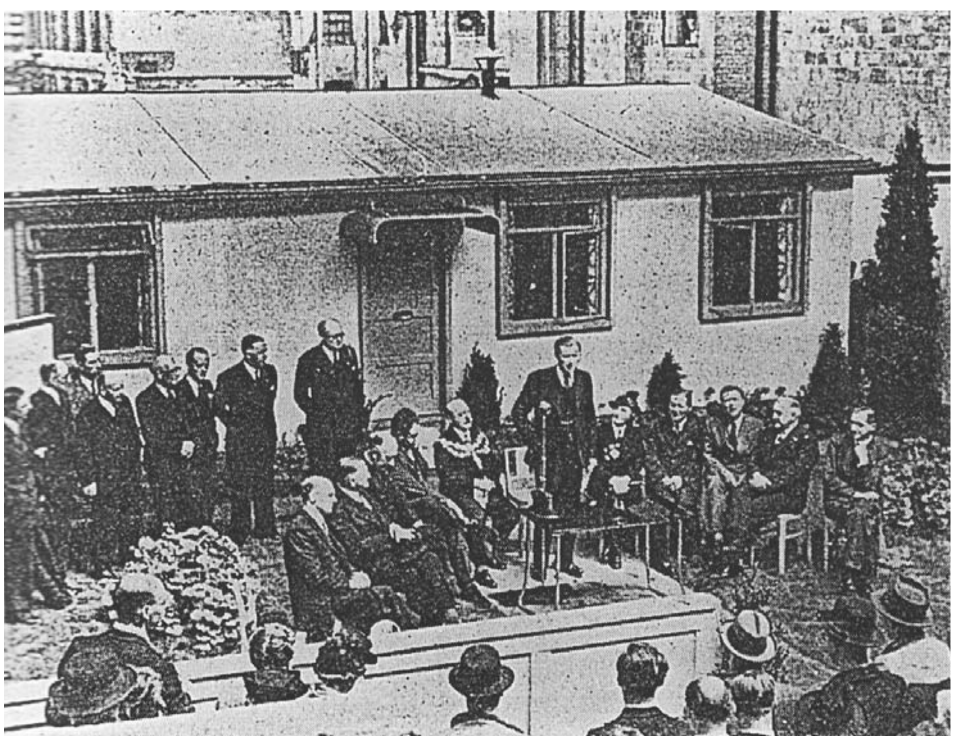
In March 1944, Prime Minister Winston Churchill announced The Temporary Housing Programme (THP) with the plan to build half a million Portal Bungalows, though by the time the Housing (Temporary Accommodation) Act entered the statute books in October of that year, target numbers had been scaled down to a quarter of a million (Churchill 1944, p. 359).

> In April 1944, the veil of secrecy, which had surrounded the early work of the Portal Pressed Steel Bungalow, was lifted. The Government had decided wholeheartedly on a Temporary Housing Programme. It was Spring, the Germans had been defeated in Africa, the Russians were advancing, the tide had turned and for the first time thoughts could be adjusted to post-war problems (Arcon 1948, p. 4).

In a complex interweaving of foreign and domestic policy, events occurring elsewhere in the world were influencing possibilities and priorities at home, down to the very shape of the houses to which soldiers serving overseas would return to live. In May of that year, a prototype was erected in the grounds of the Tate Gallery in London to be viewed by the Minister of Health (under whose portfolio housing fell at that time) and local authority representatives (Vale 1995, p. 110). However, continuing overseas obligations and sustained demand for munitions meant the excess steel capacity that had been anticipated could not be released. The all-steel bungalows never went into production and just four prototypes were produced. The government turned instead to other companies already working on prefabrication and to industries, like aluminium, where surpluses were becoming available.

'Prefabs' became the topic of much discussion in government, industry and the media. Churchill's announcement prompted BBC radio to broadcast a series of discussions about housing, called 'Homes for All.' Mrs White, a soldier's wife interviewed in one of the programmes, said: "I'd like to be one of the women who are going to see the model and have their chance to express their views about it. They might do one or two up nicely for exhibition so that people can see what they look like," she suggested (BBC 1944, cited by Vale 1995, p. 127). Not long afterwards, a revised Portal bungalow, an Arcon, a Tarran and a Uni Seco, were put on exhibition in the Tate Gallery courtyard. An Aluminium bungalow went on show the following summer behind Selfridges in London, as part of the Aluminium Development Association's exhibition 'Aluminium from War to Peace' (Figure 3.19).

Figure 3.19 Formal opening of the Aluminium prefabricated bungalow by the Minister of Works at the Aluminium War to Peace Exhibition behind Selfridges Department Store, London (*The Architects' Journal*, 21st June 1945)

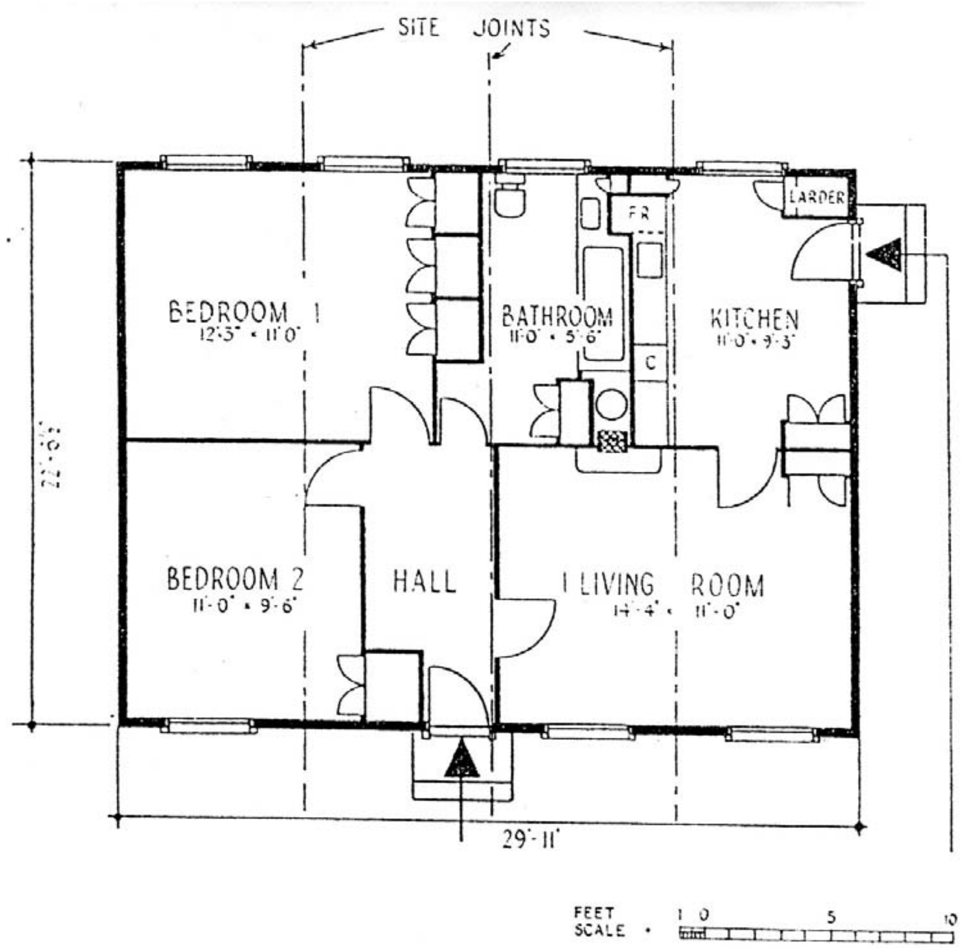


Used with permission from The Architects' Journal

Public feedback was invited. *The Times* reported from the House of Lords that "it was intended that not only experts should view these houses but also the younger women who would be the future tenants" (1944, p. 8). In a letter to the editor also published in *The Times*, a group of artists and members of the Bloomsbury Group expressed their opinion of who they thought had the relevant expertise, arguing that "the convenience or inconvenience of these bungalows is a matter for experts – *i.e.* housewives" (Bell *et al* 1944, p. 5). Some prefabs, complete with kitchen units and refrigerators, journeyed much further afield for exhibition purposes. One was erected in India "so that demobbed soldiers could see what they were coming home to," explained Hugo Jones (MMB), an architect involved in prefab production, and another was set up "in the vicinity of the Pyramids" to illustrate materially to soldiers stationed in Cairo the postwar promise of well-equipped and modern homes (*Picture Post* 1945).

The first prefabs to go up were imported from the United States. Tottenham in London received the first batch and served as a training ground where construction teams learned how to recognise the parts and piece them together correctly (*The Times* 1945, p. 2). The training disciplined workers to carry out set manoeuvres in a predetermined order to make the components fit. In doing so, the operatives themselves were also being fitted into a kind of 'assembly line' on each building site. Manufacture of prefabs in Britain began in 1946. Though they differed in their materials and techniques of manufacture, each had a similar floor plan constructed around the kitchen/bathroom core (Figure 3.20).

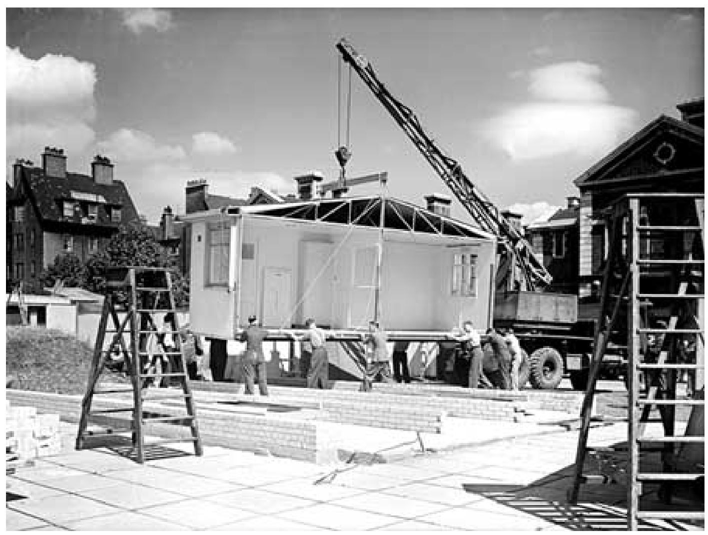
Figure 3.20 Plan of the Aluminium bungalow



Source: Ministry of Health/Ministry of Works 1944

The Aluminium bungalow was the most highly prefabricated of all the models and, when assembly lines were running at optimum capacity, an entire prefab could be completed in as little as twelve minutes (White 1965, p. 145). Each was produced and transported in four sections specially designed to fit on a low trailer (Figure 3.21). The sections arrived on site, fully wired, glazed and painted and were lifted in position on a pre-prepared concrete slab by crane (Figure 3.22). Once the final section was in place, they were bolted together and sealed, with little finishing work required other than connecting them up to electricity, gas, water and waste (Figure 3.23).

Figures 3.21, 3.22 & 3.23   Erecting an Aluminium prefab outside the Tate Gallery, London, 1945



When Taylor Woodrow Construction erected a pilot run of Arcon prefabs in Croydon, Surrey, the company took the opportunity to shoot a training film as a way for novice crews to see erection techniques in action (Vale 1995, p.8). But they were also curious to see just how quickly a prefabricated bungalow could be erected. Contractors "started work at dawn and by midday the house was ready for occupation, the fire was lit, water heated, and dinner in the oven," all in time for the Mayor of Croydon to have lunch in it that same day (Arcon 1948, p. 11; Vale 1995, p. 20, citing Squire 1984, p. 100). Even if not built quite this quick in practice, prefabs did go up astonishingly rapidly compared to masonry houses. To local residents they seemed to 'spring up' virtually overnight. Not unlike a brand new appliance, a bungalow was delivered from the factory by truck, requiring little more than a connection to a power source for it to be ready for domestic use. As former prefab inhabitant David Abbot (MMB) put it: "they just plonked them down and plugged them in!" These houses and their fittings were 'instant.' Designed to have a temporary lifespan, they were also 'disposable.' The message that could be taken from this was that it was appropriate – modern, even – to use consumer products and then throw them away. An example of inbuilt obsolescence on a grand scale, they played a role in training people to become 'good consumers.'

Electrolux won the initial contract to supply 1.5 cu ft built-in gas-powered refrigerators, while Prestcold and BTH supplied the electric models (DoRDeC 1957b, p. 5). These were purchased in bulk by local authorities and included in the tenants' rent. The government's Central Valuation Committee (CVC) debated at some length about whether the fittings included in prefabricated bungalows should be rateable, that is, whether appliances like refrigerators should be used in the calculation of the gross value of the dwelling, which would affect the rates payable by tenants to local councils (CVC 1947). Although the committee eventually decided against this approach, it is striking that, even at just 1.5 cu ft in size, a refrigerator was 'big' enough to increase the value of a house.

Although built as emergency housing and intended to be temporary, standards in the prefabs were remarkably high compared to most working-class housing at the time and the overwhelming popularity of prefabs with their residents has frequently been noted. This is attributed, in part, to their symbolic associations (Vale 1995, p. 26). In his history of the bungalow form, Anthony King (1984) explores its origins as a middle-class recreational housing type that would have been beyond the reach of most people. These temporary bungalows were the first detached dwellings to be made available to the working classes. They often had large gardens, highly prized for growing food as rationing continued into the 1950s. The other key feature highlighted by bungalow residents was convenience. As the Central Valuation Committee noted, “it is known that, despite their uninviting appearance, these bungalows are very popular because of their appeal as labour- and furniture-saving houses of an efficient design and concept” (CVC 1947). The ease of running them was closely associated with being compact, having domestic appliances and having central heating instead of open fires. A survey conducted by a subcommittee of the Women’s Group on Public Welfare (WGPW) on Scientific Management in the Home revealed that housewives generally found cooking, cleaning, childcare and laundry easier in a prefab than in their previous homes; in addition, half found these routine tasks became more difficult once they moved on to permanent houses (WGPW 1950). In a happy melding of nostalgia and technology, each factory-made temporary bungalow “managed to combine both traditional and futuristic qualities without compromising either. It was a cottage on its own plot but a cottage that contained the latest labour-saving kitchen and a central heating system” (Vale 1995, p. 173).

The novelty of having a fridge is a theme repeated again and again; indeed, the quote that Vale selected as the opening line of her book *Prefabs* is about a fridge: “It had a built-in fridge – a real luxury in them days” (Vale 1995, p.1, citing Hubbard 1985, p. 91). Nash, a curator at the Museum of Welsh Life, describes the prefabricated bungalow as “a triumph of space planning” (MoWL 2004). The prefabs’ built-in kitchens (see Figure 3.24) were carefully designed to make efficient use of limited space and came equipped as standard with a sink and draining board, hot and cold running water, gas or electric cooker, built-in gas or electric refrigerator, washboiler and wringer, work surface with built-in cupboards beneath, ventilated cupboard for vegetables, shelving, plate rack, pot rack, broom cupboard, folding table and power points for an electric kettle and an iron (WGPW 1950, p. 3).

Figure 3.24 Prefab kitchen, Museum of Welsh Life, c. 1950

While a fridge was one of the most notable features for many, it is important not to overlook the fact that even having hot and cold running water would have been a luxury for some. At the 1953 annual conference of the National Housing and Town Planning Council, Barnstable drew attention to the long-running problem of substandard homes. Many working-class houses still lacked amenities such as an inside bathroom, electricity or hot water supply "or, in many cases, a piped water supply of any kind. Not yet slums, such houses cannot be replaced for another thirty years – a long time to wait for the housewife condemned to work seventy hours a week in such homes" (Barnstable 1953, p. 47). Pauline Weaver moved to her prefab from a gas-lit house that shared a tap and toilet with neighbours; "when we arrived at the new house, my mum and gran thought they had moved into Buckingham Palace" as it had electricity, a bathroom and, once more, "even a gas fridge" (Rhodes 2004). Nash notes that "the other luxury was the fitted bathroom with its heated towel rail. … Little wonder that the prefabs were affectionately known as 'tin palaces'" (MoWL 2004).

Dennis Barber (MMB) recalled how huge his family's suburban prefab seemed compared to Leicester's infamous Wharf Street slum terraces, where he previously lived with his mother and brother. He described the three of them living, eating, sleeping and washing in the one-room flat, sharing a bathroom with neighbouring flats and making do with a wardrobe as a makeshift pantry from which, all too often, "the milk would fall on your head." He marvelled at the prefab's central heating, electric cooker, fridge, built-in cupboards and bathroom; "it was the bees knees. … The paper called them the latest in prefabricated dwellings – they called us the prefab kids." While Barber was proud to have been one of the first 'prefab kids,' other residents were less enthusiastic. David Abbot (MMB) experienced it as a source of shame and, when growing up, was reluctant to admit where he lived. Despite the stigma he felt at the time, even he had fond memories of it later:

> Now people are sentimental, they're quite sought after. In a museum in London they had one. It was exactly the same. It had a fitted fridge and cooker, heating and a bathroom. That was a good level of accommodation.

It had been an especially good level of accommodation in the eyes of those for whom sub-standard housing, over-crowded conditions and poor sanitation were the norm. The exhibit to which Abbot refers was in the Science Museum in London. In 1967 the museum acquired an Arcon kitchen/bathroom unit from a prefab that was being demolished, in order that one be preserved as an important artefact in British social history:

> The kitchen-bathroom unit designed by the Ministry of Works and the Pressed Steel Co. Ltd is a landmark in the history of British housing. Never before had such fine equipment been provided as standard issue in state aided housing (Arcon 1948, p. 11).

Although prefabs went up much more rapidly, it was soon apparent that factory production was proving more expensive than conventional housebuilding, not less. Target construction costs were hopelessly optimistic. The THP did not produce prefabs on a sufficient scale to be cost effective and the rationale of shifting labour from building site to factory was not as successful as had been hoped. Given the spiralling production costs, Vale questions whether motivations other than housing people quickly and cheaply lay behind the programme. In Churchill's first announcement of the programme, he commented that "these houses will make a heavy demand upon the steel industry and will absorb in a great measure its overflow and expansion for war purposes" (Churchill 1944, p. 360). The THP may perhaps have been as much about seeking a peace time product to absorb the factory capacity that had been built up through war work, to keep production lines busy and to create new jobs, for the twin concerns in the immediate post-war were employing ex-servicemen as well as housing them (Vale 1995, p. 132, 136). Right from the outset, when Portal outlined the plan for prefabricated bungalows, Lord Barnby had suggested that equipping these bungalows with consumer goods would generate further demand for such products, on the basis that when those residents moved on to permanent houses they were likely to want the same level of equipment; "thus it would be possible to stimulate a national demand for a product that very few people had yet seen in ordinary housing" (Vale 1995, p. 114).

In the end, the number of prefabs constructed was relatively small. From Churchill's initial aim of half a million, to the rapidly-revised target of half that amount, eventually just 156,623 prefabricated bungalows were built during the three years of the THP (Vale 1995, p. viii). Nevertheless, I argue that their impact went well beyond the 150,000 or so families who inhabited them. Prefabs were highly visible. They were exhibited to the public, discussed at length in the newspapers and on the radio, and 'sprang up' virtually in front of people's eyes across the country. Even if people did not live in them, they certainly knew about them. Intentionally or otherwise, prefabs generated a high level of exposure for the refrigerator. Most significantly, they also brought refrigerators within reach of working-class households for the first time. A report by the Domestic Refrigeration Development Committee (DoRDeC) in 1957 claimed that:

> these 'pre-fab' installations widened public experience of refrigeration and there is little doubt that the present demand for refrigerators largely derives from the favourable publicity thus gained (DoRDeC 1957b, p. 5).

Notwithstanding the limited proportion of the population who had first-hand experience of living in one, the postwar prefab provided an important boost to the adoption of the refrigerator in Britain. "Whatever else they would have accomplished by these houses," *The Times* coverage from the House of Lords reported, "they would have initiated and popularized a type of fitting which he [Portal] thought in time would be incorporated in all permanent houses in this country. … By including these fittings the Government would have set an example for which in years to come many young people would be grateful," a statement that, according to the news report, was met with cheers (*The Times* 1944, p. 8).

Refrigerators may have made it onto the list of standard fittings in the Burt Report on temporary housing, but they ultimately failed to do so in the 1944 report on the *Design of Dwellings*, known as the Dudley Report, which set the standards for permanent housing in the postwar period. Scott (2003) reveals that early drafts of the Dudley Report did include a small refrigerator, along the lines of those provided in the prefabricated bungalows, indicating that for a time it had been poised to become 'standard' in the postwar home. However, the fridge was not destined to survive through subsequent revisions and was omitted in the final draft. Government standards were not to be the vehicle for its mass adoption. Instead, its entry into British homes would be left up to the market. The next chapter takes us into these homes and explores the ways in which people learned to use refrigerators.

Chapter 4

Getting a Refrigeration Education

When I talked with interviewees over those many cups of tea and asked how they learned to use a fridge, my question was often met with blankness. Few thought of it as something involving active learning. “I don’t think it’s something that you really need to ‘learn’!” (Michelle), “well it’s obvious really” (Gwen), “just common sense” (Dorothy). I disagree. I argue that, on the contrary, using a refrigerator is premised upon the acquisition of certain knowledges, rather than being ‘self-evident’ in the way that it is frequently assumed to be. What I see in my interviewees’ answers is a powerful sign of the extent to which a relatively recent technology, historically speaking, has become normalised. But more than that, their replies suggest that the learning which accompanies the introduction of this technology has become internalised to the extent that it is no longer understood as something actively learned but is labelled ‘common sense.’

In this chapter, I ask from where and whom people gained their knowledge about refrigeration. I ask about the ways, both formal and informal, that this knowledge travelled; how it got turned into ‘common sense’; and the kinds of common misconceptions that circulated alongside. I start by exploring the professional transmission of domestic knowledges through the work of Appliance Demonstrators as they guided users through techniques of hands-on learning and observation. From here, I turn to the textual transmission of knowledges about how the refrigerator operates and how it should be used. I focus on a selection of handbooks and instruction leaflets produced by manufacturers, consumer organisations and individual authors dating from the 1920s to the current day. In their explanations about how to organise and manage food for convenience and health, the handbooks deploy discourses of scientific authority and many were framed quite explicitly as transmitting knowledge from the laboratory into the home. Although I concentrate on the early period of refrigerator use, from 1928, when mechanical refrigerators first arrived in Britain, to the late 1950s, I also draw comparisons with more recent material. I examine what these handbooks told readers about the benefits of the refrigerator in the home, the roles it – and they – should play, and the ways refrigeration and freezing could be incorporated into a range of new cooking practices. I also ask what users learned about their own work in the process of learning about refrigeration technologies and argue that the act of framing the refrigerator as a labour-saving appliance serves to conceal particular kinds of labour.

FRIDGE KNOWLEDGES

A little over fifty years ago, in 1956, a group of refrigerator manufacturers decided to come together to form the Domestic Refrigeration Development Committee (DoRDeC) and publish a *Domestic Refrigerator Guide*. In what could be characterised as a form of governmentality deployed through consumer capitalism, the organisation had a dual remit "to increase the knowledge and understanding of the benefits of the domestic refrigerator" and to lobby the British government for more support to help the domestic refrigeration industry, still relatively new in Britain at that point, to get established (DoRDeC 1957a, p. 3). In DoRDeC's view, people needed to be educated to understand (and presumably to want) home refrigeration. For a practice to thrive, it must recruit practitioners who become carriers of routinised ways of 'understanding' or 'knowing how' (Shove & Pantzar 2007). As Reckwitz points out, a practice also involves routinised ways of 'desiring' (2002, p. 249). On the question of why just 8% of British homes had refrigerators when over 90% did in the United States, DoRDeC attributed the low figure to insufficient knowledge:

> One major reason would appear to be the general lack of knowledge concerning the benefits of a domestic refrigerator. Evidence of this is given by Miss Ann Smith [a Housecraft Advisor]. On a recent visit to eight council flats, all provided with a refrigerator, Miss Smith found only three of these were running. The other five she was told made wonderful cupboards for family mending. In the flats where the refrigerators were running, the milk was on the doorstep or window-sill and the remains of the Sunday joint were on the kitchen table. One housewife said that her neighbour had told her the meat would go black if kept in a refrigerator (DoRDeC 1957c, p. 5).

The passage illustrates that during the 1950s people frequently misunderstood the purpose of a refrigerator and did not regard it as a technology relevant to their needs. The DoRDeC membership was strongly of the view that this needed to be remedied in order to improve demand, sales and 'standards of living.' The situation in those eight council flats showed a clash of different organising and preservation systems and we see a struggle between competing knowledges written into the placing of things within these homes. Things previously regarded as being in their proper place when distributed among window-sills and kitchen tables were now considered 'out of place,' according to organising logic of the refrigerator. When held up against the disciplining and containment offered by mechanical refrigeration, their presence in these spaces starts to be regarded as symptomatic of domestic disorder and disarray. To the residents of these flats, however, neither the function nor the value of the refrigerator was self-evident. They struggled to see how a fridge would fit into their practices for its use was not yet obvious, not yet common sense. More 'obvious' to some was that this appliance looked and acted like a cupboard and, in the absence of a better purpose for it, they happily appropriated it as such. For the woman who had been convinced that the refrigerator would make her meat go black, using it to store mending instead of food could perhaps be thought of as a case of 'common sense.'

Domestic training

In interviews, discussion soon turned to where and how people acquired household skills in general, and where they picked up ideas about food preservation and refrigerator use in particular. Two things struck me as particularly interesting in these conversations. First, the mixture of ways in which people learned – formally and informally, consciously and not, from schools and books, from observing others and from trial and error. Second was how much people struggled to answer these questions. This was partly due to the challenge of remembering just where these knowledges had come from, knowledges gained long ago, gradually and in subtle ways, but it also stemmed from the challenge of articulating or even conceptualising tacit forms of knowledge. Tacit knowledges are associated with practical and social skills, such as how to cook, use tools, mend things, raise a family, perform caring work or interact in social settings. Largely unconsciously, we pick up and store the rules of etiquette, such as how to behave in certain contexts, what kind of things to eat at certain times of day, the proper way to organise one's home or, for that matter, one's fridge.

At least for Janet, the source of her domestic training seemed quite clear. She described herself as someone who has always loved being in the kitchen and very much enjoyed her domestic science classes at school. Almost all the women I spoke to had had some formal home economics education in school, even if this was fairly rudimentary. When Alice Poutney

(MMB) received her schooling in the early 1920s, domestic skills were a highly important, as well as a highly gendered, component of her education. While the boys did gardening, the girls did cookery because, as she put it, if you could not cook you could not get a job. Most girls of her age and class went into service and in her case she started work as a housemaid at the age of thirteen. In Janet's case, what she learned at school was broadly similar to Alice in content. Where it differed was in cultural expectation and the degree of mechanisation. Janet was being taught how to be a housewife rather than how to be a domestic servant. She was unusual in having had a very thorough programme of domestic training where she was taught not just cooking but a much broader range of housecraft skills as well. The high school she attended had two large kitchens, sandwiched between which was a flat where pupils were instructed how to run a home and taught skills like how to dust, how to iron and how to wash by hand. Using a refrigerator was an explicit part of the school curriculum for her in a way that it had not been for others I spoke to and Janet recalled being told in class that the refrigerator was definitely "a thing of the future." She and her classmates were taught why they should use a fridge rather than a larder and how it would enable them to store things for longer periods and help reduce waste. Janet's daughter, Lisa, struggled to remember exactly where her knowledge about refrigerators and food safety came from, though she had vague recollection that some kind of government public awareness campaign had influenced her understanding of food handling:

> You know all these safety things you get on the television about how to cross roads safely, I'm sure I've had at some point in my lifetime things about where you keep food in fridges, one of these very old, what do you call it, 'public service announcement' type adverts. I did do home economics at school, but I can't remember if we talked about fridges at school. It may have been from my mum, who's very careful about things like that, but I have a feeling it was more to do with a public awareness service.

Disseminated by a central body on a national scale, this kind of broadcasting initiative seeks to raise awareness of various issues among the public and encourages them to regulate their own conduct, not only in public spaces, but also in the home.

Ronnie was widowed four years ago and now lives alone, but even during the majority of his married life he took responsibility for virtually all household tasks. His wife, Pauline, was severely disabled by arthritis. She used a wheelchair for the last eleven years of her life and was very limited in what she could do physically. "I did everything," Ronnie emphasised, "washing, cooking, the lot. She couldn't do nothing." Ronnie had evidently acquired a more comprehensive range of domestic skills than most men of his generation. I asked whether he had picked these up as a matter of necessity at home but he explained that much of his training came from his time in the armed services, where he served as a batman/waiter (an orderly or assistant to an officer) in the Officers' mess. He told me that the training, discipline and skills helped to make him self-reliant and able to look after himself, for these were competences he was able to translate into the home with little difficulty.

Learning by 'osmosis'

At Iris's school, all the children spent half a day a week at a different school where girls were taught cooking and sewing and the boys were taught carpentry. Nevertheless, both she and Gwen told me in their interview that the majority of their learning had been informal. Though Elsie (MMB) had cooking lessons at school, she was sure that she had picked up most of her domestic skills through helping her mother with cooking and household tasks. Her brother's chores involved looking after the animals, while hers always entailed helping around the house with laundry, ironing, washing up and making beds. Mothers trained daughters to make them the homemakers of the future, Elsie emphasised, adding that when she was growing up, "women never went to work. Being at home was the job." It was accepted as 'normal' "and no one complained." Frances observed that her brother "knows how to do all the things boys are supposed to do and I, by osmosis, learnt how to do all the things girls did like cooking and sewing." In these women's experiences, clear gender divisions were evident from an early age and reinforced both at school and in the home. Childhood has been described as a form of 'apprenticeship' beginning in infancy during which children are trained how to behave in socially appropriate ways and learn how to think, reason and see the world through culturally specific interpretive lenses (Power 2000, p. 3; Zerubavel 1997). Interviewees' narratives supported the idea that we learn in subtle but powerful ways from the roles and behaviours modelled by those around us; for example, gender-coded messages from the discourses comprising 'kitchen culture' instruct women "how to behave like 'correctly' gendered beings" (Inness 2001, p. 4). Thus, as well as learning household skills and how to use a fridge, these women were also learning femininity.

Most of my interviewees' learning took place informally, to the extent that many did not think of it as 'learning' at all, so internalised had become their food management behaviours. Iris and Gwen's accounts show how, for them, practical and embodied forms of knowing were primary. Neither used recipes or weighed ingredients when they cooked but talked about learning in a way that has similarities to Frances's notion of 'osmosis.'

> Iris: With cooking, I used to say to my mum 'can I help?' and she'd say 'no, go away, I can do it quicker myself.' I used to watch her, but I was never actually taught to cook. … It's common sense. You peel potatoes and you know when they're cooked, or cabbage. Most of it is just common sense. … I suppose this is the way we grew up. You just learn it.
>
> Gwen: Like with custard, if you stop stirring it it comes out lumpy. Somehow you learn by making mistakes, don't you?
>
> Iris: or with pastry, you just know if it needs more milk by looking at it.

They watched. They made mistakes. In time, they just knew by looking. Their knowledge, acquired from experience and embodied in their practices, had become unconscious. Looking, tasting and smelling were crucial 'technologies' of cooking and food management. I asked whether when they got a fridge they had been taught to keep things in particular places or how long to keep them for. "I don't remember ever being told" said Gwen. "Well, it's a natural thing you learn," Iris commented.

Just how common is 'common knowledge'?

It is this apparent naturalness that interests me. It crops up in two slightly different formulations: first in the notion that refrigerator use is inherently 'obvious' or 'self-evident,' like some kind of innate ability with which people are born; and second in the form of Iris's comment above where she recognised that something was being learned but conceived of it as something picked up quite 'naturally' as part of a stock of knowledge that people inevitably acquire. Such knowledges can, indeed, become common knowledge, or at least common to people in certain shared socio-cultural contexts. My point is that 'common knowledge' is learned. It is knowledge that has been *made* common, and, thereafter, assumed to be naturally so. But misconceptions can be common kinds of knowledge too.

Contextualising technologies by thinking about the times and places in which they were initially encountered helps one to appreciate the cultural logic of behaviours that might otherwise seem curious or even comical. For instance, in the early days of domestic electrification many peoples' understanding of electricity was limited:

> The only thing they had to compare it with, at least in the home, was gas. What they knew about gas was that it sometimes caused fires, and sometimes leaked from lines and unlit jets. Naturally, the same assumptions were applied to electricity. It seemed perfectly reasonable that an empty light socket would leak electricity into a room (Sammond 1995, pp. 32-3).

Following the recommendations of the Tudor Walters Report at the end of the First World War, local authority housing began to be wired for electric lighting (Tudor Waters Committee 1918). The warning issued to tenants of the Becontree estate in east London not to wash lightbulbs by dunking them in water hints at how novel this form of lighting was at the time (Ravetz 1995, p. 132, citing London County Council 1933). As quaintly misconceived as lightbulb washing might seem now, in the context into which electric lightbulbs were introduced, the cleaning of light fittings was something neither odd nor especially risky. In homes lit by gas, gas mantles *would* have been things that were cleaned and people unfamiliar with electricity would have no reason to know that water and electricity do not make a happy mix. Even the introduction of flush toilets involved a learning curve and there is evidence that using the flushing system properly required some guidance and direction. "The unfamiliarity of early council tenants with their first flush toilets is reflected in their managers' warning to 'treat the flushing system carefully. Pulling the chain with a jerk damages it.' … This could take long familiarity and much skill to 'pull the chain' effectively, to the frequent bafflement of foreigners" (Ravetz 1995, p. 140, citing Dagenham Borough Council 1956, p. xx). Neither the proper way to flush a toilet, nor the principles of using a refrigerator, should be assumed to be obvious.

Janet recalled her elderly neighbours being very distrustful of refrigerators. Initial scepticism is not unusual with the introduction of new technologies and Pantzar notes that this was the case even with piped water, considered by some to be unnecessary or even harmful to health (1997, p. 57). Just as Ralph Raimi's parents in the previous chapter misunderstood the ice production process, so Janet's neighbours were wary of a cooling process that they did not understand and regarded the refrigerator as something dangerous. They knew there was some kind of gas contained in them, which made them highly doubtful about the wisdom of bringing one inside their home, for fear that the gas could escape and cause an explosion. Although this might come across as unduly cautious, their reservations could also be considered quite sensible, given that they grew up at a time when warnings were frequently issued about the safe use of gas appliances in the home. Moreover, because the earliest domestic machines operated using chemical refrigerants that were toxic and explosive, their worries could be seen to have some merit.

My interviews revealed a diversity of refrigerator knowledges, some learned in schools but most acquired either at 'Mother's knee' or by means of trial and error. From here, I turn to look at knowledges gained through formal training opportunities, such as EAW's certification programmes on electrical appliances, and passed on to customers during demonstrations in homes and showrooms.

LEARNING THROUGH OBSERVATION AND PRACTICE

The photograph below (Figure 4.1) was taken in 1946 in Halstead, Essex, and shows members of an EAW class for Demonstrators, instructed by Miss Kay Wilson of Edmundsons' Electric Corporation. Against the backdrop of a banner celebrating electricity and its consumption, which proclaims that "electricity should not be merely supplied but lavished that men may use it at their will as the air they breathe," they would have learned about the theory and the practice of electrical appliance use. Shown in the image are a few of the appliances with which participants developed practical expertise, along with a selection of sectioned models and diagrams used to teach the technical principles upon which they operated. As demonstrators, these women would have played an important role helping consumers understand and use appliances effectively.

Figure 4.1 EAW training course for Demonstrators, Halstead, Essex, 1946.

Figure 4.2 depicts a GEC (General Electric Company) cooking demonstration. It clearly shows that such demonstrations, especially at larger fairs and exhibitions, were attended by an audience of men as well as women. Although women would generally be the users of these appliances, purchases were often by men because married women were not permitted to sign hire-purchase agreements without the permission of their husbands.

Figure 4.2   GEC cooking demonstration, undated

I was fortunate to be able to interview Jenny Webb, who spent her whole career in the electrical industry. She decided at an early age that if she could not be an actress then her second choice was to be an Appliance Demonstrator. "In those days they were really 'Queen Bees,'" she said of the first generation of demonstrators, and credits them with opening up the energy industry to women. Demonstrating was regarded as a high-status and fairly glamorous career option for women. "In one place I worked I had my own demonstration theatre," she told me, "I even had my own toilet, my own office." Her job positioned her quite prominently in public view and she enjoyed the opportunity it gave her to exhibit her technical expertise, demystify contemporary 'cutting edge' technologies and communicate a genuine passion about electrical appliances for the home. Jenny was one of the women who undertook EAW and EDA training in the 1950s and 1960s. She passed the EAW certificate in Electrical Housecraft for Demonstrators in June 1957, the Diploma for Demonstrators in 1962 and the EDA Electrical Salesmanship course three years after that. The examiner's report for her EAW Diploma examination gives an insight into the knowledge, skills and qualities on which demonstrators were tested. Jenny was required to give a formal hour-long talk and demonstration in which she used an oven, a washing machine, a food mixer, a kettle, an airer and an iron; cooked a meal; used and discussed all parts of the cooker; and handled "questions on unit-storage heaters, fractional horse-power motors and water heating and the relative efficiencies of spin dryers and drying cabinets." She was particularly commended for her rapport with an audience and her ability to communicate her enthusiasm for electricity in the home.[48]

Jenny was hired by the London Electricity Board (LEB) in 1955 as a Trainee Demonstrator. Part of her job involved visiting people in their homes and in this role she observed first-hand the confusion, lack of knowledge or lack of confidence experienced by many consumers who were new to electrical appliances:

> In those days when anybody bought an appliance, it didn't matter what it was, I would send them a note. 'Dear Mrs so-and-so, you just bought X and if you would like me to come around to demonstrate it to you or talk to you about it please make an appointment.' *So I spent a lot of my time also trotting around visiting people to tell them how to use their appliances, because they didn't know.* You know, if they had a washing machine, I'd do some washing, if they had a cooker, I'd do cooking (my emphasis).

She stressed that it was important to remember that many people were still quite unfamiliar with electricity in the mid 1950s. Even when homes were wired for electric power, residents did not necessarily have much grasp of how it worked or much experience with appliances. Part of the training she offered was in the correct use of refrigerators. The most common misunderstanding she encountered was when people assumed they should switch off their refrigerator at night, just as they would any other electrical appliance. The refrigerator was peculiar among appliances in that it had to remain on all the time, so one of her key tasks was educating people about the need to leave their fridges on. Some people's reluctance arose from fears about the cost of constant electricity consumption. Others simply found it counter-intuitive. They had successfully internalised the message that appliances should be switched *off* for safety reasons; now they had to learn, also for reasons of safety, to leave their fridge switched *on*. After being promoted to Demonstrator, Jenny worked in showrooms throughout her region where she dealt with customers, handled complaints, and put on weekly appliance demonstrations. Figure 4.3 shows one of the demonstrations she gave with the LEB in 1965.

48 Examiner's Report, A. Pickford, 12/10/62, Electricity Council Archive, the Museum of Science and Industry in Manchester.

This was a 'West Indian Evening,' which formed part of the LEB's attempt to reach out to a more culturally diverse audience.

Figure 4.3 Jenny Webb, London Electricity Board 'West Indian Evening,' 1965

After ten years as a Demonstrator, Jenny was appointed as a Housecraft Adviser by the Electricity Council at its Appliance Testing Laboratories at Leatherhead. Here, she headed up the Performance Testing Department and was responsible for a team who tested a full range of domestic electrical appliances under laboratory conditions (see Figure 4.4). She emphasised to me how new this process was and how steep the learning curve for new technologies was, even for those within the industry. Her role involved formulating the test specifications for appliances because there were no pre-existing standards. As she recounted "I used to go lecture at universities and stuff because *nobody* knew how to test in those days." It was a legal requirement that electrical appliances were tested to ensure they complied with British Electrotechnical Approvals Board standards. Even though performance testing was not mandatory, manufacturers did tend to send products to her to test, "so we had manufacturers making sure they reached the electrical standard but also saying 'crickey! We've got to send it to Jenny Webb and her crowd.'" She would often discuss performance aspects with manufacturers at the prototype stage. Product user manuals were usually written in-house, but some companies contracted her to write the user instruction handbook. In a very direct way, therefore, Jenny herself was responsible for the 'scripting' of many British kitchen appliances in the 1960s and 1970s.

Figure 4.4 Jenny Webb (far left) at the Electricity Council's Appliance Testing Laboratory

LEARNING FROM REFRIGERATOR HANDBOOKS

There is a rich history of advice on domestic organisation and efficiency, from Catharine Beecher (1841), Isabella Beeton (1861), Christine Frederick (1913; 1920) and Lillian Gilbreth (1927), through countless consumer guides and magazines, home makeover shows and celebrity chefs, to Delia Smith, Nigella Lawson and Martha Stewart (Ehrenreich and English 1979, Leavitt 2002). Increasing numbers of women turned to magazines for domestic advice in the post World War One period. *Good Housekeeping*, launched in Britain in 1922, rapidly became an influential and well respected authority on all matters domestic and a market leader in what developed into a huge consumer market for women's magazines. The magazine set up a test kitchen to test all the recipes it published. This evolved from a makeshift stove arrangement in its Fleet Street offices to the 'Good Housekeeping Institute,' an independent consumer research centre, opened in 1924. The Institute presented talks, staged cooking demonstrations, assessed food products and also tested new consumer products such as vacuum cleaners, ovens and refrigerators. Those appliances meeting high standards were awarded the 'Good Housekeeping Seal of Approval.' Alongside recipes, fiction and fashion advice, *Good Housekeeping* therefore became a key site for the discussion of new domestic technologies.

> Women's magazines played an important part in educating women to [consume] in a disciplined and 'responsible' way. Although the emphasis on commodities was, if anything, less than in women's magazines today, with rather more fiction and fewer advertisements, where attention *was* paid to new goods on the market it tended to be heavily informative and education. The visual layout often resembled a trade catalogue. Many features were meant to 'test' housewives on their ability to 'choose wisely' and there were regular 'shopping guides' informing the reader of what was available in the shops and offering advice on what to look for (Partington 1989, pp. 207-8).

These kind of magazines helped readers navigate the appliance market by offering an independent source of knowledge and opinion. In this next section, I concentrate on a sample of texts dating from 1928 to 2003 to see how they endeavour to educate refrigerator owners about fridge management and use. The texts include handbooks, recipe books and instruction leaflets which would have accompanied the purchase of a refrigerator (Frigidaire 1928; GEC 1932; BTH 1943; Prestcold 1943; Electrolux 1950; Princess 1952), as well as literature from organisations such as the EAW and DoRDeC (1965; n.d.), an example of a general handbook, *Your Refrigerator*, from a commercial publisher (Williams 1962), and the draft of a booklet, *Food from the Fridge*, given to me by Jenny Webb (Webb 2003). For simplicity I refer to all of these sources as 'handbooks' below.

Sinister facts and safe spaces

Prior to the 1960s, the handbooks address the housewife directly and position her in relation to her caring responsibilities and the role of protecting her family's health:

> Without doubt, the health of your family means more to you than anything else in the world. You are willing to make every effort to protect it; you learn to buy wisely, to plan the right kind of meals, and to prepare those meals in the very best way you know how. But do you know how essential to good health is the proper care of food in your home? Do you know why food spoils and how you can prevent it? (GEC 1932, p. 15).

Despite her best intentions, careful planning and fastidious performance of her duties, our housewife's endeavours may not be enough if she lacks certain crucial knowledges. The texts explain that the principal threat to food comes from bacteria. Betty Williams goes into more detail in her book by discussing Pasteur's research and the connections he made between food putrefaction and micro-organisms "so small that they are invisible to the naked eye and so can enter our food unseen, where they multiply at an alarming rate" (Williams 1962, p. 11). The real cause for alarm is learning that "food spoilage can sometimes be detected by its appearance or odour, but it is possible for food to be contaminated and unfit to eat although it *appears* good" (Electrolux 1950, p. 4, emphasis in original). The BTH handbook reiterates the seriousness of this situation. "The sinister fact is that food kept in an ordinary larder may contain harmful germs without showing a sign of mouldiness or smelling in the least odd" (BTH 1943, p. 7).

Appearances can be deceptive so any housewife would be unwise to rely exclusively upon her senses, given how hard it is to be entirely confident at all times about the condition of ones food:

> At some time or another we have all had to throw away food which has been contaminated by flies, and when food is left on an open shelf it is impossible to ensure that flies do not settle on it – a couple of seconds is more than enough for the damage to be done (Williams 1962, p.12).

Williams draws readers' attention to laboratory tests which show that houseflies can transmit diseases such as dysentery, typhoid and tuberculosis. "The only way the housewife can be sure she is doing her part," the GEC handbook emphasises, "is to keep [food] at a low, even temperature (below 50°F) under the most clean conditions, and in an atmosphere which is pure and fairly dry" (GEC 1932, p. 15). That the solution to the problem of contamination takes the shape of a refrigerator comes as no surprise. Repeatedly we are told that only a mechanical refrigerator "provides space for keeping foods safe, fresh, and wholesome. Its low, dry temperature – always below 50°F – ensures proper refrigeration and palatable dishes" (BTH 1943, p. 9). The notion of 'proper refrigeration' soon stabilised to mean the maintenance of a consistent temperature between 40-50°F – a range Kelvinator shrewdly appropriated as 'The Zone of Kelvination.' Fifty degrees Fahrenheit became the temperature "which modern science agrees is the danger point" because above this temperature bacteria multiply, but below it they remain dormant (Prestcold 1943, p. 3). People were taught that the outward indications of spoilage formerly relied upon as warning signs could no longer be considered adequate. Because deterioration could not necessarily be detected without the aid of scientific tools, official bodies declared practices such as the housewife's sensory readings of her foods to be insufficient to safeguard health without the aid of refrigeration technology.

To care for food responsibly meant storing it in conditions where growth of bacteria and moulds were inhibited. Confidence could come only from removing foods from risky spaces conducive to bacterial growth, like the warm, moist conditions common in domestic kitchens. Williams makes a contrast between the larder, where she finds it impossible to keep bacon fresh for more than two days in summer, and the refrigerator, where it lasts for well over two weeks (1962, p. 12). She emphasises that a larder cannot protect food from fluctuating temperatures, dust or flies in the way a refrigerator can, for instance, even with the fridge door open, flies will not willingly enter this cold environment (DoRDeC n.d., p. 3). A cold, contained space – a space apart from the dangerous warmth of the kitchen – starts to assume the status of something crucial to the maintenance of food, and therefore health.

Battling the invisible organisms of spoilage

Early handbooks worked hard to promote year-round refrigerator use:

> Do not imagine that your Electrolux Refrigerator is necessary only in summer time. On the contrary, in a climate with constant fluctuations of temperature in the cold season, food is constantly undergoing changes it if is stored in a larder. … These changes have a very undesirable effect upon nutritive values, particularly in the case of milk, butter and meat. For food to retain its freshness and full nutritive value, it must be stored in your Electrolux whatever the season (Electrolux 1950, p. 4).

Handbooks emphasise the variability of both temperature and humidity throughout the year and repeatedly made the argument that it was not uncommon for kitchen temperatures to rise above 50°F, even in winter. Food could deteriorate rapidly in such conditions, they explain, because "changes of even a few degrees give the invisible organisms of spoilage their chance" (GEC 1932, p. 16). "Remember then," BTH cautioned, "if you want food to retain its full nutritive value, and give the maximum of nourishment to the body – you must use your refrigerator all the year round" (1943, p. 8). Failure to do this becomes a failure to fulfil ones responsibilities for feeding and nourishing.

In a 1959 issue of *The Refrigerator Guide* (DoRDeC 1959, p. 6-7), DoRDeC committee members reported on a 'long-keeping test' they conducted to see how long a range of foodstuffs could successfully be kept in a refrigerator. All the foods were still fresh after ten days. By two weeks salad items were beginning to wilt and beef was turning. At three weeks, milk and cream had started to sour, but butter, cheese, pastry mix and sausages were still good, thereby demonstrating that many basic foods could be safely stored for three weeks or more. DoRDeC stressed not only that the refrigerator could extend the shelf life of food significantly, but also that 'correct' storage methods could be taught. Although there was heavy emphasis upon the ability of a refrigerator to keep food fresh and safe, the handbooks were careful to point out that the refrigerator was not a long-term solution and could not preserve perishables indefinitely. In the cold environment within a refrigerator, bacterial growth is considerably slowed, but it does not cease altogether. Shelf life is largely dependent on the condition foods are in when they arrive in the refrigerator and the journey they took to get there; "the longer it takes food to reach the refrigerator shelves from its source – whether from the shop down the road or the fisherman's prize catch – the shorter the time it can be kept at home" (DoRDeC n.d., p. 7). Research and experimentation could give guidance about storage times, but "much depends on a common-sense attitude as to how long foods will keep their freshness." Thus, in the end, determining the length of time foodstuffs will remain both safe and appetising comes down to a combination of science and common sense. Here, it seems, individual judgement is being partially written back in. By extending the capabilities of the housewife, the refrigerator is cast as a co-producer of her family's health, an 'ally' she can rely upon to help guard against an unseen enemy threatening the wellbeing of those for whom she has responsibilities of care.

The care and feeding of the domestic refrigerator

Most of the handbooks begin with some form of 'guided tour' around the refrigerator, walking the reader through the interior, showing where the mechanism is housed, drawing attention to the shelf space, the frozen food compartment, the chiller underneath, the shelves in the door and the various compartments designed for butter and eggs, ice cubes, milk bottles and salad stuffs. They then go on to give detailed directions for refrigerator 'care,' which primarily involved cleaning and defrosting, and 'feeding,' that is, what to store in the cabinet and how to arrange it. BTH explains that "your refrigerator … requires very little assistance from you in caring for your food supply. You must help in two ways only: by keeping it clean and arranging the food properly in its food compartment" (1943, p. 9).

Cleaning

Users are reminded that the refrigerator must be washed periodically to remove "any taint arising from odd pieces of meat, fish, butter" and so on. "The shelves and walls should be kept free from butter or grease which might become rancid," and anything spilled inside, particularly fruit juice or vinegar, which could cause discolouration, should be wiped up immediately (Electrolux 1950, p. 9). The recommendation is usually to clean the interior using a damp cloth and bicarbonate of soda dissolved in warm water. Handbooks warn against using soap or detergents with a strong smell which might transfer to foodstuffs, or abrasive powders that might damage the enamelled surfaces of the early models. However, the task does not end there. Readers are told that the exterior should also be cleaned regularly with warm soapy water, rinsed, rubbed dry, and polished with a silicone furniture polish; BTH adds a reminder not to neglect the chromium plating either because it needs maintenance to prevent it from deteriorating (1943, p. 12). Users are advised that defrosting offers a convenient time for cleaning, although it is "very simple" to wipe off dirty marks in the interim (Williams 1962, p. 25). BTH's suggestion is to empty and clean the refrigerator monthly, though other manufacturers recommend doing so weekly. Instructions to 'remember' or 'not forget' litter the passages on cleaning, reinforcing the idea that users responsibilities include not simply the physical work of cleaning but also the cognitive work of keeping track, of keeping the refrigerator in mind. Additionally, the task of cleaning begins to sound more onerous than it initially appeared when expectations for the quality of cleanliness are examined; the refrigerator should be 'spotless' (Princess 1952, p. 3; DoRDeC 1965, p. 14), 'scrupulously clean' (Princess 1952, p. 7; BTH 1943, p. 12; DoRDeC 1965, p. 4), even 'immaculately clean' (Prestcold 1943, p. 5). For everything to be kept so perfectly clean, it seems that the housewife must be the perfect cleaner.

Interviewees generally squirmed a little when I asked questions about how often they cleaned their fridges. "Probably not often enough!" was a typical reply. In my discussion with Jenny Webb, she mentioned that at one stage manufacturers contemplated supplying special refrigerator cleaning fluid with the purchase of a fridge, not because fridges actually needed a special kind of fluid to clean them, but because of the symbolic work this container of fluid could do. Although it could not guarantee that cleaning would get done, it could act as a cue to signal the importance of regular cleaning, helping manufacturers act 'at a distance' to shape ongoing refrigerator practices.

Defrosting

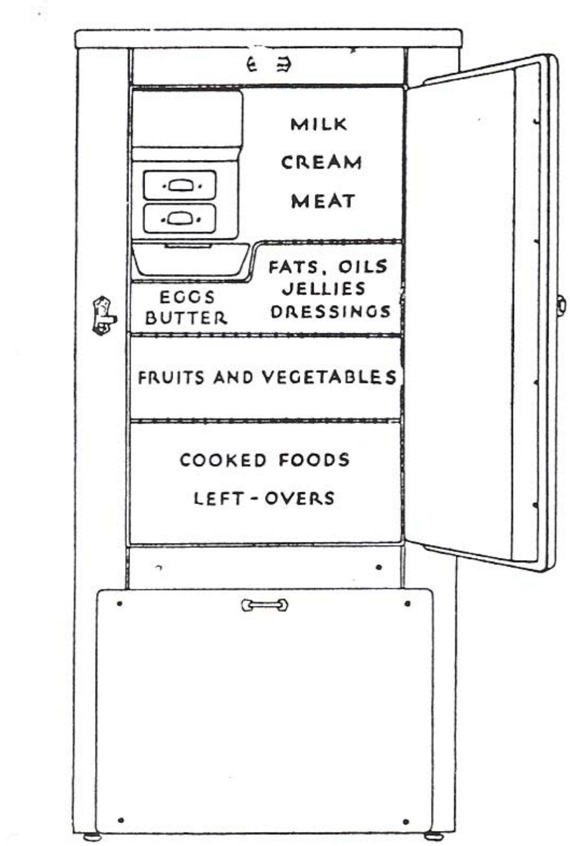
During use, a layer of frost gradually forms around the freezer compartment as moisture extracted from the air and food inside the cabinet condenses. This must be removed regularly by defrosting because, if permitted to accumulate, the ice will impair efficiency. The cooling system relies on air flowing across the pipes to transfer heat away. When ice builds up, it acts as an insulator and reduces air flow. This means the unit has to work harder to keep cold, which increases running costs. How, and how often to defrost varies with the age and type of the refrigerator. Frigidaire and BTH recommend monthly defrosting, whereas Williams advises doing so every week. Her reasoning is partly because having a weekly routine makes it is easier to remember (Williams 1962, p. 24). Interestingly, here increased physical work is advised as a way to ease the work of remembering. Other manufacturers suggest that the user should be guided by the quantity of ice instead. DoRDeC recommends defrosting when ice is no more than the thickness of a pencil and Tricity advises "on no account allow the frost build up to exceed quarter inch," guidance which aims to train users how to 'read' the state of their refrigerators for themselves (DoRDeC 1965, p. 12; Tricity n.d.).

Early models were manually defrosted, either by turning a dial to the defrost setting or simply switching the refrigerator off altogether, removing the contents, leaving the door open and letting the melt water collect in the chiller tray, perhaps with a bowl of hot water placed under the evaporator for encouragement. Users are cautioned to allow the ice to thaw naturally rather than to chip away at it for fear of damaging the evaporator; just "forget about the refrigerator while you get on with your other household jobs," advises Williams (1962, p. 24). When complete, the user should empty the drip tray, clean and dry the interior, reset the dial or restart the machine and, once it has returned to its proper temperature, replace the food (DoRDeC 1965, p. 13). Frigidaire, in contrast, suggests it is not necessary to remove the food at all, arguing that "while it is defrosting, the food compartment is kept cold by the melting of the frost" (1928, p. 75). With the introduction of semi-automatic defrosting, pushing a button stopped the operation of the refrigeration mechanism until the frost melted. The refrigerator then started up automatically once defrosting was complete. Fully automatic defrosting, as the name implies, requires no intervention from the user. The motor switches off at regular intervals, any water produced evaporates and the temperature rise is minimal, meaning that food does not need to be removed (DoRDeC 1965, p. 13).

Mapping and ordering

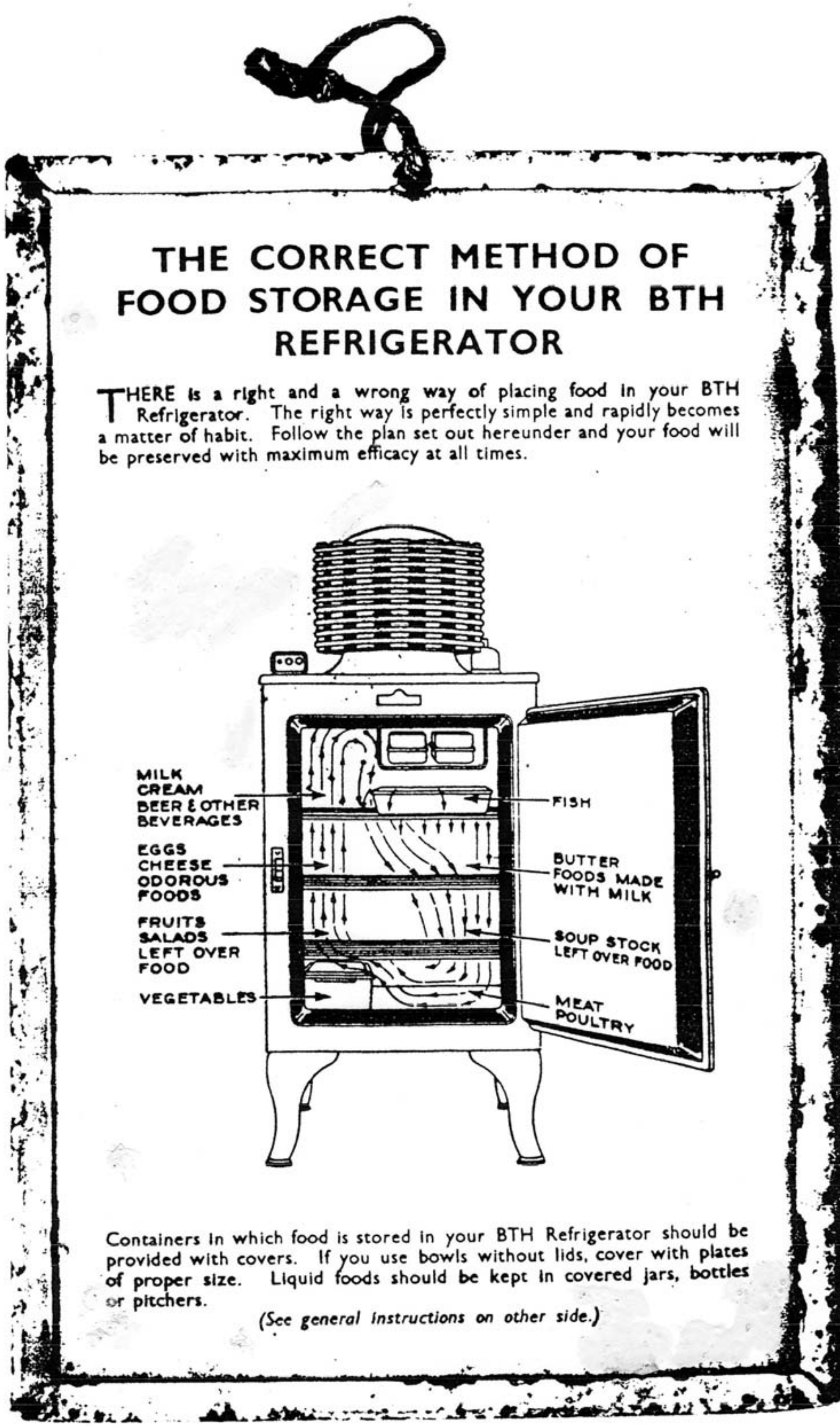
The second way BTH listed to 'assist' one's refrigerator, was by arranging food 'properly.' Early instruction manuals gave considerable attention to the appropriate placement of foods inside the cabinet. "Wherever you put food in the refrigerator, it will be safe," Williams assures her readers, before elaborating on the slight temperature variations and the pattern of air circulation which make certain foodstuffs more suited to certain locations than others (1962, p. 21). Many of the handbooks provide diagrams to illustrate the best positions for milk, butter, cheese, fish, fresh and cooked meats, vegetables, salads, fruits and even leftovers, often accompanied by explanations relating this arrangement to the characteristics and behaviour of the foods, such as those prone to dry out or to absorb odours (Figure 4.5).

Figure 4.5 Diagram of the correct arrangement of food in a Frigidaire (Frigidaire 1928, p. 10)



A 1932 BTH instruction card entitled *How to take care of your BTH Electric Refrigerator*, which hung from the door handle of newly purchased refrigerator, states that "there is a right and a wrong way of placing food in your BTH Refrigerator. The right way is perfectly simple and rapidly becomes a matter of habit" (BTH 1932). One simply follows the 'map' provided (Figure 4.6).

Figure 4.6 The correct method of food storage in your BTH refrigerator (BTH 1932)



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Handbooks encouraged users not to overfill the refrigerator. Leaving space between each item is necessary to allow good air circulation and efficient refrigeration. “Foods packed tightly together on the refrigerator shelves tend to reduce cooling efficiency and shorten their own storage life” DoRDeC explains (n.d., p. 7). The BTH diagram above indicates the direction of air flow around the interior and captures a sense of the dynamic system in operation behind the refrigerator door. The instruction not to open the refrigerator door for any longer than strictly necessary is another common theme. Because heat moves from warmer to cooler spaces, warm air will flow into the cabinet every time the door is opened. The warmer the air inside, the more cooling work the compressor must do and the higher the running costs. This is why cooked foods should be cooled to room temperature before being placed in a refrigerator. Once the internal temperature becomes elevated, the ‘pull down’ time required for it to return to the correct temperature can be lengthy. East Midlands Electricity warns people not to put warm dishes in the refrigerator, for “if you do it may take your fridge hours to recover its temperature,” compromising its efficiency and running the risk of raising other foods in the refrigerator above safe temperatures (East Midlands Electricity n.d., p. 4).

As for how to prepare foods for storage, all the handbooks explain that foods stored in the refrigerator should be covered or wrapped to keep them in good condition. The circulation of cold air has a drying effect because moisture evaporates from food items as heat is drawn out of the cabinet. A second reason is to prevent strong odours passing between foods; fatty foods like butter and milk have a tendency to absorb the flavour of those foods with a strong smell, like fish or onions. Readers are advised that butter should be covered and cheese wrapped; meat should be wiped and rewrapped (but not washed until it is time to cook because this draws out the juices and accelerates spoilage); fish should just be lighted wiped and placed in the chiller tray, whereas poultry should be thoroughly washed and drained; eggs are best kept in a wire basket for ventilation; leftovers should be cooled completely; greens should be washed and trimmed, firm fruits like apples washed or wiped, soft fruits left unwashed to help prevent them getting overripe or mouldy and bananas should not go in the fridge at all. Readers are also reminded not to keep anything in the refrigerator, like canned goods, which will keep just as well out of it.

My intention had been to trace a chronology to examine how the instruction materials changed over time but my most striking observation was just how consistent the messages in these texts remained. The guidelines are remarkably similar across the handbooks from 1928 right up to 2003; indeed, in place after place the wording is identical, indicating that the instructions for best practice have remained very stable. In the Electricity Council archives at the Museum of Science and Industry in Manchester, a handwritten note from Gwen Concher, a Home Economist, tucked inside a book by LEC on deep freezing reads "Plagiarism – or calm cheek? It's a very cheap and nasty 'lift' of our book, and where it is original, it has some funny passages! (Funny peculiar)." The most significant additions that we see in later books and leaflets are warnings about avoiding contact between raw and cooked meats to prevent cross-contamination. Readers are instructed to keep raw meats covered at the bottom of the cabinet, well away from cooked foods at the top. Close proximity between meat in its different states brings risk so a spatial separation is necessary but, more than just a case of keeping them apart, they also need be ordered in a particular way, with raw meat located below the cooked to ensure that meat juices cannot drip onto foods beneath.

Complex internal geographies were created as divisions and demarcations proliferated in many refrigerator models. "In effect, the micro-climates inside the refrigerator were to be treated as standardized sites for different types of food handling," Grahame explains (1994, p. 296). In 2001, Gigiel, Evans and Hammond spoke of exciting developments underway to develop a multi-temperature refrigerator which had different compartments at different temperatures to allow very accurate temperature control (2001, p. 13), but such an initiative is less novel than it might sound. Back in 1940, a Westinghouse advertisement for the *Leisure Line* of electric home appliances states that "five kinds of cold are needed *and provided* in this roomy Westinghouse Refrigerator" (Lupton 1993, p. 14, emphasis in original). International Harvester goes further in a 1953 advertisement: "It takes 7 different areas of cold – from 6ºF to 55ºF – to keep basic foods like these in prime condition. You get all 7 of these essential Food Climates – all working at once – in the New 7-Climate Refrigerators." Thus, manufacturers and consumer organisations encouraged refrigerator users to organise and store their food according to the principles of "a new and rationalized freshness topography" (Isenstadt 1998, p. 318). In the next chapter, I discuss in more detail how my interviewees organised the foodstuff in their fridges.

Cold Cookery

Beyond its primary purpose of preserving food, access to refrigeration in the home also opened up new food preparation possibilities. Key among these was the concept of 'cooking with cold.' This represented:

> an entirely new application of the household refrigerator. … It is common household knowledge that various degrees of heat are required for practical cooking of foods. The same principle holds true in freezing desserts, only in the opposite direction (Frigidaire 1928, p. 3, 11).

Though commonplace today, things like chilled salads and frozen desserts were very novel foodstuffs in the early days of the domestic refrigerator and became fashionable, high status foods. By experimenting with new foods and new technologies of 'cooking,' the domestic scientist and the curious user produced new domestic knowledges. My initial surprise that chilled sweets and salads should be greeted with such an enthusiastic response helps illustrate that 'cold cookery' was itself eventually made ordinary and proceeded to join the stock of 'common household knowledge' to which Frigidaire referred.

In this section, I explore the introduction of the new practice of 'cold cookery' by focusing on a 1928 Frigidaire handbook. Produced just one year after refrigerators started being imported into Britain from the United States, this would have been one of the earliest texts dealing with the 'applied science' of cold cookery available in Britain. Frigidaire's handbook takes us into The Frigidaire Experimental Kitchen where, in a marriage between scientific and domestic knowledges, new recipes were formulated and tested. Four photographs accompany this section of the handbook, two depicting a Home Economist in her white lab coat, and all four showing measuring instruments, like temperature dials and thermocouples, prominently positioned on top of the refrigerators. "This scientific equipment has been included in the kitchen in order to learn certain fundamental principles about dessert freezing. The knowledge thus gained is passed on to Frigidaire users in the booklet" (1928, p. 9). Explicitly framed as a medium by which knowledges produced in a laboratory-kitchen travel into domestic kitchens, the handbook represents the journey that 'scientific' knowledge takes into domestic spaces and practices.

Chilled dainties and the physics of dessert

In her experimental kitchen, the Home Economist tests recipes, takes accurate measurements and perfects dessert-making techniques. This information is sorted, streamlined, simplified and translated into a set of instructions to enable the non-specialist to reproduce the dish at home. "No recipe is released until the ingredients and proportions produce a delightful dish, which may be frozen easily and speedily in Frigidaire … with very little effort, and in the simplest, surest way" (Frigidaire 1928, p. 8, 10). The intention is to keep both 'effort' and 'complexity' out of domestic kitchens, relocating them to this experimental space. An 'expert' – a scientist whose field of research is salads and desserts – becomes the delegated holder of scientific knowledges on behalf of multiple users who benefit at-a-distance from her stock of knowledge and expertise.

Frigidaire's booklet introduces the reader to the concept of differing 'degrees of cold' and explains how the refrigerator's Cold Control technology regulates cold in much the same way that an oven regulates heat. A variety of desserts can be created because "freezing speeds, different degrees of cold, are provided for every need" (Frigidaire 1928, p. 3, 11). As with any kind of cooking, the preparation, handling and combining of ingredients affects the flavour and the texture of the dish. Sugars, fats and acids respond differently to changing temperatures and require different amounts of energy to freeze. Temperature can affect the texture of foods, as can the rapidity with which those temperatures are reached. The formulation of Frigidaire's recipes was based upon the behaviour of and interactions between ingredients at low temperatures, something unlikely to have been common knowledge at the time. We learn, for instance, that cream and fresh fruit fare better when frozen more slowly than sherbets or ice cream, that ice cubes are more attractive when the water freezes slowly, that chocolate cream needs a lower temperature to freeze than plain cream and that the secret to making ice lollies which do not fall apart when sucked is to make the mixture more acidic and less sweet (Frigidaire 1928, pp. 12-13; Princess 1952, p. 14). Some ingredients require a temperature well below zero to freeze, but by strategically manipulating the relative proportions, a mixture can be made to freeze at temperatures above zero instead. This 'scientific' approach to cooking tells the user that accurate measurements are crucial, for if the balance is out and a mixture contains too much sugar, it may not freeze at all (Frigidaire 1928, p. 15).

There is much discussion in the texts about ‘frozen dainties,’ the preparation of which Frigidaire describes as “one of the greatest delights in owning a Frigidaire” (1928, p. 12). Indeed, the recipe book ends with the final pages left blank, save for a heading inviting the reader to add “delightful frozen dainties of your own.” Refrigerator recipe books generally included numerous recipes for ice creams, sherbets, mousses and parfaits and the Frigidaire handbook outlines in detail the various methods of freezing different desserts. It also reassures the reader that this information is clearly explained in each recipe so does not need to be memorised, a move that positions the requisite knowledge as something located in the text rather than in the user (p. 12). Encouraged to try out new desserts, users are told not to be despondent if these dishes do not turn out as hoped; “if it is not entirely satisfactory the first time, re-read the method of preparation and method of setting the Cold Control and try again, for the power is there at your disposal” (p. 16). The message is that these capabilities are available to the user (presuming the user to be a careful reader), but reside within the text and the technology. The implication is that any fault lies with the user; any skill, with the machine.

Adventures in salad

The refrigerator was considered responsible for the ‘reinvention’ of the salad. “Not so long ago a salad was a damp arrangement of limp lettuce dotted with slices of tomato and cucumber with a bit of hard boiled egg thrown in if you were lucky,” but with the aid of a refrigerator, “today it can be a dream of a dish combining all sorts of contrasting flavours and exotic ingredients (Williams 1962, p. 70). Salads evolved into an array of sweet and savoury dishes, from fruit or garden salads, to moulded salads and aspics, or substantial dishes forming the central component of a meal. Williams urges the housewife to experiment with recipes and be adventurous with salads because “your family will be sure to enjoy something so entirely new in flavour” (p. 70). This point should not be underestimated. Without practical ways to cool foods in the way a refrigerator could, eating chilled dishes would have been a taste experience new to many palates. ‘Coolness’ came to stand for foods that were fresh and appetising. “Any dessert fruit is improved by chilling,” claims Frigidaire; “stewed fruit, trifles, etc. are far more delicious when chilled before serving,” the Princess refrigerator affirms (Frigidaire 1928, p. 28; Princess 1952, p. 10). Newly fashionable, consuming chilled foods became a mark of having modern tastes.

Learning to love leftovers

The role of the refrigerator in minimising waste was also emphasised. Leftovers, particularly protein-rich foods, are presented as 'value-added' foods because they contain "important food value for which we have paid, and have spent time, energy and fuel in preparing. … Protein is one of our most expensive foods and is necessary for body building and repairing, so every bit should be used" (Frigidaire 1928, p. 55, 57). The argument is that, thanks to a refrigerator, leftovers become an 'asset' rather than a 'liability.' They also offer opportunities to demonstrate creativity and ingenuity: "frequently one can transform left-over foods by skilful combining into very inviting salads of any type" (Frigidaire 1928, p. 41). The housewife is vested with responsibility to provide varied and attractive meals. The handbooks acknowledge that this can be a challenging prospect in the case of leftover food. "Few of us tackle the combining of odds and ends of food with the same zest with which we approach the preparation of food fresh from the grocer's or butcher's. The idea has permeated the minds of the family so that often they do not greet these warmed-over or made-over dishes with great enthusiasm" (p. 55). Emphasis was laid on the need for items to look different for 'the second service.' We are told that with the help of a refrigerator, these can be made "as inviting and appetizing as when they made their first appearance." (p. 55). The refrigerator's ability to keep leftover foods for a number of days helped give the housewife the means and opportunity to prevent her family from recognising Sunday's left-over roast when it appeared later in the week as meat pie, mousse, croquettes, aspic mould or gateau (Electrolux 1950, p. 7; GEC 1932, p. 9). Fridges relieved the pressure of having to use up leftovers immediately or risk them going to waste.

Doubling the charm of your cocktails

If you have ever spent time wondering how to "double the charm of your cocktails," apparently the easy answer is to use ice cubes, for "these are cheap to make and most welcome, because the average person so seldom gets iced drinks outside a restaurant" (BTH 1943, p. 23-4). Obviously still a novelty at this time, and not easily accessible outside of certain kinds of spaces, ice cubes were not just something valuable for cooling for they also "add refreshing attractiveness" (Frigidaire 1928, p. 53). Recipe books suggested, for variety, making ice cubes using fruit juice or coffee, adding food colouring or even making decorative cubes with lemon slices, cherries, mint leaves, candied fruit or rose petals frozen inside. In parallel with changes in food preservation practices came shifts in the conventions of entertaining. With a refrigerator, an informal supper for guests can be “a simple matter with salad ready to place on lettuce, sandwiches prepared ahead, a frozen dessert in a freezing tray and coloured ice cubes for cooling the beverage” (Frigidaire 1928, p. 73). While the three-course meal was firmly entrenched as the norm for dinner parties, a popular substitute for the traditional first course of soup became a cold savoury or sweet appetiser. Williams enthuses that almost any cocktail party food will be improved by chilling, whether canapés or ‘something-on-a-stick’ (1962, p. 113). Claiming to bring “new joy in entertaining,” the refrigerator was also promoted as a tool to reduce the stress of visitors arriving unexpectedly. “If a part of one shelf in your refrigerator is reserved for an ‘emergency corner’, it will be space well spent” recommended GEC (1932, p. 18). Similarly, Williams argues that “if you make full use of your frozen food compartment you need never be at a loss to know what to serve at any time of the day, and there will be no more panic at the sight of the unexpected guest … because the ever-expanding range of frozen foods makes it possible to serve a complete meal in the shortest possible time” (1962, p. 29). As a holding space in which to store supplies in readiness for any unexpected arrivals, a fridge facilitates practices of hospitality. In so doing, it also reaffirms the housewife’s social role as hostess and her responsibilities for feeding and for entertaining others.

Hidden work: baffled by a Princess

On the matter of the kinds of labour for which the housewife has responsibility, and the skills with which she is credited, I examine one instruction book more closely to see how work and competence are distributed. The Princess refrigerator was designed to be defrosted without the need to remove food from the main body of the cabinet, just from the freezer and the chiller tray. This is presented as labour saving innovation. I argue that, despite this claim, considerable work was still required from the user, but that work took a somewhat different shape and got eclipsed from view.

The instruction booklet supplied with the Princess refrigerator recommends that the user defrost the fridge as soon as the frost builds up over a quarter of an inch. Even deciding to defrost requires paying attention, monitoring and making a judgment as to when that point is reached. The procedure is then to empty the freezer and chiller, set the dial to DEFROST, then close the baffle and the door. When defrosting is complete (and, again, this necessitates checking the cabinet and assessing whether the process is 'complete' or not), the instructions are to empty out the water collected in the chiller tray, "thoroughly dry" the freezer, tray and baffle, put them back in place, reset the control to NORMAL and open the baffle. None of these actions are arduous. This is not heavy work. However, there are many small steps to keep track of and lots of removing, replacing, setting, resetting, checking and deciding to do.

As with all the refrigerator handbooks, cleaning is presented as a key responsibility and one that begins even before the refrigerator is used. Prior to switching it on, the owner is advised to "fetch a soft cloth and wash the inside of the cabinet spotlessly clean" (Princess 1952, p. 3). The booklet suggests that the most convenient time for regular cleaning is likely to be when defrosting it, although "cleaning can be done whenever you think it necessary provided you remember to turn the control knob to OFF and keep the door open until you return the control to its usual position" (p. 6). Cleaning involves emptying the cabinet, wiping each surface (using two different kinds of cleaning product: a mix of water and bicarbonate for the inside, and a mild soap or detergent for the outside) then polishing the outside, not forgetting, of course, to change the setting before and after. Cleaning requires not only physical work but also lots of remembering work – remembering to do it regularly, remembering to use the right products in the right places, remembering to alter the settings back and forth as necessary.

The Princess refrigerator has a range of capabilities, each of which require the user to perform a series of steps. Individually, these are simple procedures, but together they form a sometimes fiddly combination of action, memory and judgement. For example, making ice cream involves planning ahead to set the control at COLDEST half an hour in advance, then making the mixture, freezing it, checking it and deciding at which point it has "frozen hard" before removing it and returning the setting to the usual position (p. 14). Even making ice cubes involves a set of decisions. If desired, the freezing rate can be accelerated by setting the knob to COLDEST and closing the baffle, remembering, as always, to return the knob afterward.

The importance of the responsibility to remember is underlined: "*The control knob should not be left on* COLDEST *nor the baffle left closed when you have finished ice-making. Turn it back to its usual position and open the baffle as soon as possible*" (Princess 1952, p. 11, emphasis in original). Failure to remember has consequences as it carries the risk of freezing everything in the cabinet.

It goes on.

The control knob has various settings. Most of the time it should be left on the NORMAL setting, unless defrosting, when it should be set to DEFROST. When cleaning it, or away on holiday, it should be switched to the OFF position. Each of these is a fairly deliberate action and the expectation that we would alter the dial on each of these occasions might not be unreasonable. However, it becomes more complicated when we learn that the dial should also be adjusted if room temperature deviates from 'normal.' Altering the settings in such instances involves a much more subtle and complex set of judgements about how much warmer a room must become to warrant a change in refrigerator temperature. It assumes that one maintains an awareness of temperature fluctuations. It also assumes that the refrigerator remains in a sufficiently prominent position in one's mind to think to alter the setting.

And there is more.

The baffle, like the dial, also has different temperature settings. It should be open in the summer, and during any unusually warm spells in the winter, but closed when the room temperature drops. As with the dial, this carries an expectation of ongoing monitoring on the part of the user, of consciously paying attention to changes in room temperature and of thinking to adjust the refrigerator settings as necessary.

But that is not all.

We learn that when storing frozen foods the baffle should be closed, "unless very short term storage is required" (p. 10). We are left to judge how short 'very' short term is. Then there are potential contradictions to be resolved, such as the dilemma that comes with storing frozen foods when room temperature is high. Would the baffle be best closed to accommodate the frozen food, or opened because it is warm? Which priority outweighs the other?

It is all a bit baffling.

Ultimately, perhaps the detail is less important than the fact that certain kinds of work are being saved, just as the promotional materials claim, but at the same time other kinds of work are being concealed. The physical labour of lifting, moving and walking may be reduced, but other forms of work are substituted. This refrigerator, with its multiple settings, makes demands upon its user and requires greater awareness of changing temperatures, more forward planning and more remembering. It assumes an attentiveness to servicing its operating needs. The BTH refrigerator discussed earlier "requires very little assistance from you" other than to "help" it in just one or two ways. The language in these handbooks has the effect of constructing the housewife as helper or assistant to the machine. She is told it is an object that will save her work, but it comes with needs and demands of its own, for close attention needs to be paid to its operation and to the conditions of its immediate environment. As one more body to be cared for, it acts to reinscribe the housewife's caretaking and facilitating role.

The foreword of the GEC *Silent Treasure Handbook* observes that "fortunately, those days are past when the homemaker must sacrifice all outside interests for the sake of her home" (1932, p.2). The text lists a range of new domestic technologies that have saved the housewife time and labour. It is notable that this saving is usually calculated in terms of 'steps.' The idea of saving steps, which lay at the core of the postwar kitchen efficiency movement, is captured especially vividly in a Norwegian film called *Kitchen Stories*, directed by Bent Hamer. One character involved in conducting time and motion studies in Swedish kitchens comments that:

> As Dr. Ljungberg likes to say, the Swedish house wife needs no longer walk to Congo during a year of cooking. Now northern Italy will suffice (Hamer 2003).

The GEC handbook explains that first came the iron, which saves "several miles a year." Then came the vacuum cleaner and the washing machine, which also benefitted cracked hands and aching backs. "Each new electrical appliance contributes its share to the lightening of household tasks," it continues:

> *And now* the electric refrigerator. Not only can it save the housewife time and energy, but it can actually *work* for her. With a little planning on her part it can take an *active* part in the preparation and serving of her meals. … So many new avenues are now open to owners of electric refrigerators that few yet appreciate its full value (GEC 1932, p. 3).

This refrigerator is active. It helps to prepare – even serve – the meals for which the housewife is responsible. It is helpful to examine these claims critically and pay attention to the different kinds of work that are involved. While the work of walking and lifting might be minimised, we see more planning and remembering required in their lieu. All our housewife needs to do is "a little planning," the implication being that her role is minor and does not really count as labour. In BTH's *Silent Servant: a treasure book for housewives*, we learn that "planning 4 meals a day, 365 days a year, is either a most interesting game or a task of deadly monotony" (1943, p. 18). This acknowledges that constant planning can be tiresome, but seems to present it as something boring rather than difficult. However, a BTH refrigerator, "with its ability to make all sorts of delicious and inexpensive chilled sweets and savouries, will certainly give you a new interest in the whole question." *It* is making those delicious dishes and in so doing removes the work and the 'monotony' to turn it into a much more pleasurable 'game.'

The language in which technological progress is couched has a tendency to relocate conceptually certain abilities. Work by feminist historians of technology such as Cowan (1983), Wajcman (1991) and Cockburn and Ormrod (1993) reveals a relative deskilling of domestic work and the transfer of attributions of 'skill' to objects and machines rather than to people. Silva (2000) shows how efforts to construct the microwave oven as an appliance of convenience have the effect of concealing significant labour and skill, most commonly that of women. Despite the functions performed by the machine, the responsibility to monitor correct cooking remains with the cook. Using a microwave demands certain basic technological skills and monitoring requires an investment of one's time as well as the application of one's judgement, but the marketing and instructional literatures downplay the input of human labour and attribute competence to the machine rather than the user. Despite the planning, the work and the physical interaction required, the discourse constructs the appliances as neutral and autonomous, thereby sustaining the claim that it is the appliances that are doing the work, making the calculations, making life easier.

BECOMING FROZEN-MINDED: FREEZING AS A NEW PRACTICE

Alongside domestic refrigeration, home freezing also emerged as a new practice and a new mindset. Betty Williams alerted her readers:

> Please note that you will become more and more 'frozen-minded' when you realise the possibilities of your refrigerator – make certain that you have an adequate freezer compartment. Manufacturers are constantly improving this section of the refrigerator … as they become more aware of its potentialities (1962, p. 19).

Rather than implying any sense of fixity or resistance to new ideas, Williams' conception of being 'frozen-minded' represents an active embrace of modernity and its technologies. She is confident that users will come to appreciate the benefits of freezing as a food management practice. As the freezer starts to take up space in British homes, so it assumes a greater presence in people's minds.

Freezing is a method of controlling bacteria in food. Though the principles of quick-freezing had been known for some time, Clarence Birdseye was the first to adopt it successfully on a large scale. His inspiration came from a period he spent in Labrador in 1923 where he saw First Nations peoples preserving fish and caribou meat in ice for many months. His innovation was one of approach rather than one of new knowledge (Volti 1994, p. 48-9); the key lay in packing foods first and then freezing them afterwards. He took his observations from Labrador back with him to the United States where he developed a process for quick-freezing fish. The patent for his 'Method of Preserving Piscatorial Products' was granted in 1925 and frozen food sales began three years later. Although commercial freezing was used to a small extent in the 1930s, it was only in the post-war period that the industry really became established in Britain. Peas were the first vegetables to be frozen commercially and Birds Eye frozen peas began appearing in Britain in 1946. The availability of once-seasonal vegetables year round prompted an editorial in *Vogue* to comment in 1948 that "'quick freeze' methods have come to stay, turning our bill of winter fare topsy turvy" (cited in Furnival 1998, p. 81). Expenditure on frozen foods rose from a modest £150,000 in 1946 to an impressive £65 million by 1964 and £250 million by 1975 (Ware 1963-4, p. 173; Sheldon 1975, p. 111). Initially, most frozen foods were bought for immediate consumption as few households had refrigerators, let alone freezer facilities. Prior to 1935, refrigerators did not have a separate freezer compartment and it was only by lowering the temperature of the whole cabinet that it was possible to make ice cubes and frozen desserts. Freezers started to become more widely available in Britain in the early 1950s, but it was in the 1970s that British freezer use boomed with the mass adoption of the chest freezer (Shove & Southerton 2000; Hand & Shove 2007).

It was with genuine excitement that Jenny Webb addressed a press luncheon in September 1969 on the topic of "food freezing, as we're all now trying to call it!" (Webb 1969, p. 1). Her address is an intriguing document, coming as it does at a moment when the technology of freezing was poised on the cusp of widespread adoption. It was not entirely new or unfamiliar, but she referred to there being a level of 'mystique' still surrounding freezing, a practice popular enough to be generating appliance sales, but new enough for a common name not yet to have stuck. The reference to a deliberate attempt to standardise the terminology signals that there were variations in circulation. 1969 would prove to be a significant year for the freezer. "Britain breaks the ice and plunges into the deep freeze" proclaimed the Sunday Times (1969) as sales accelerated and freezers made their presence felt in British kitchens and daily cooking practices.

As a Home Economist for the Electricity Council, Jenny acted as an information provider to consumers. She explained to the press luncheon that the Electricity Council and regional Electricity Boards were already being bombarded with questions from an interested public who wanted to learn more about freezing and she stressed it was a crucial time for those in the industry to prepare themselves for new users and their questions. "People expect us to know all the answers," she emphasised, "so probably we, more than others, go mad with our experiments!" (Webb 1969, p. 2). The learning process for early users such as Jenny and her colleagues in the industry was necessarily experimental. As she points out, "none of us 'did' it at college," for the technology was too new. This meant "we have all had to learn our freezing the hard way," by trial and error. Instead of having the luxury of learning from best practice, they were the ones determining what best practice would look like. As a promotional strategy, Birds Eye had given free use of a home freezer to various media representatives, home economists and educators who they thought might become spokespeople and promoters of home freezing. Jenny thoroughly enjoyed experimenting, trying out new recipes and discovering what it had to offer. "I know I'm in danger of becoming a new kind of food bore once I start talking about it" she warned (Webb 1969, p. 2). That she could be a *new kind* of food bore reinforces that food freezing was, indeed, a new kind of domestic practice.

The purpose of the luncheon was an "opportunity to swap ideas and to clear our thinking so that we are all telling the same story, ready for next year" and its anticipated explosion in new users. It was part of a broader exercise in gathering and consolidating knowledge, in determining what new users needed to know, defining what the field of 'freezer expertise' might look like, and what 'the story,' to which Jenny referred, could or should be. She encouraged audience members to come and play with the display model and its contents: "here are a variety of packing materials and if you would like to see how they behave, we also have a selection of food for you to pack into them" (Webb 1969, p. 4). Rather than engaging in an abstract intellectual exercise, she promoted the benefits – and fun – of hand-on learning and experimentation. She was keen that people in the industry should be able to pass on knowledge to consumers from their own experiences, albeit always with the recognition that freezing is "an immensely personal thing" and something that would be incorporated into people's homes and habits in highly differentiated ways, depending on individuals' preferences, routines and relationships with food and family.

Jenny wanted to clarify a couple of key areas of misunderstanding in her talk. She drew attention to the important but often poorly understood distinction between "the conservator versus the real freezer," two devices with different roles and capabilities. The 'conservator' came to be better known as the frozen food compartment, so in this case hers was not the term that stuck. Intended as a storage space for commercially frozen prepackaged foods, its temperature was sufficient to 'conserve' foods already frozen, but did not drop low enough to freeze ambient foods. For those wanting to freeze fresh, home-grown or home-cooked foods themselves, a 'real' food freezer was required, one capable of reaching the much lower temperatures necessary to transform the state of foods. The second major thing she drew attention to was the 'rule' not to refreeze, and indeed this makes the top of the list produced by Gwen Concher, a fellow Home Economist, entitled *Ten Freezer Misconceptions – or Whoever told you that?* Concher describes the idea that one should never refreeze anything that has thawed, even partially, as the "commonest misconception of them all" (Concher n.d., p. 1). Also appearing on her 'top ten' list are the idea that certain foods and materials become dangerous if frozen and the concern that should a freezer break down its contents will become unsafe and must be thrown away. In essence, these three concerns encompass the fear that foods can be dangerous if frozen, and if unfrozen, and if refrozen! This reveals some important popular misunderstandings about the nature of freezing and a degree of fear about a process that was often poorly understood. Webb and Concher both go to some lengths to reassure consumers that, aside from a narrow set of legitimate safety guidelines, most of these fears can be put to rest.

People had been taught, very effectively it turns out, not to refreeze. Webb and Concher's claim that, for the most part, refreezing presented no risk went against a message that people had been used to hearing for quite some time and from diverse sources. "Do not re-freeze once thawed," the text from a Birds Eye frozen food package states clearly (Ware 1963-4, p. 180). Ware, a representative from Birds Eye, described having a conversation with housewives shopping in Kensington who said they purchase frozen foods for immediate consumption but would never store them on the basis that the instructions said not to refreeze, wording which, to them, implied that something bad would happen to it (Ware 1963-4, p. 190). DoRDeC's 1965 *Teaching Notes* tells readers that if frozen food thaws it must be used "and must never be re-frozen" (p. 13). Williams is clear about frozen items in her 1962 text: "*Never* put them back into the freezer compartment once they have been even slightly thawed" (p. 33). For her this rule raises questions even about the wisdom of semi-automatic and automatic defrosting; "we are sometimes advised that frozen foods can be left in the freezer during defrosting, but this is a very doubtful point" (Williams 1962, p. 28).

Concher and Webb set out to try and counter what they saw as the circulation of partial or incomplete knowledges. "Originally a prudent warning from the quick frozen food people in the early days when no-one had freezers and only about one third of us even had fridges" (Webb 1969, p. 4) the rule was essentially a hangover from a concern about the safe handling of poultry. As a safeguard, it was introduced as a blanket prohibition to simplify instructions for the unfamiliar users, but they considered this a blunt tool in need of being refined. With expanding freezer use and improved understanding of the characteristics of frozen foods, they argue that the 'don't refreeze' rule could now be much more selectively applied. Demonstrating the ways that stories become untethered from their contexts and "go the rounds from time to time," Concher (n.d.) tries to dispel the notion that "some foods or packaging materials become dangerous if frozen." The two explain that freezing is a very safe method of food preservation and one that will not harm food because it is essentially a natural cooling process that has been accelerated and amplified. They acknowledge that freezing has drawbacks in that, at certain temperatures, food texture may decline, but they emphasise that it is not a dangerous process in itself. Exposure to low temperatures cannot make a product toxic. So long as food is fresh, clean and in good condition when it gets frozen, it will remain that way. The risk to food comes not when frozen; instead, it is in a thawed condition that food is vulnerable. As Sheldon and Kurti note (1975, p. 117), "any freezing process is only as good as the thawing it receives later." When the protection afforded by its frozen state is removed, food returns to an ambient temperature, whereupon it is subject to the same risks as before. Cases of freezer breakdown often provoked considerable anxiety as it was a common assumption that the contents would no longer be safe to eat and must be disposed of. This returns us to the idea that thawing converts food into something dangerous. Jenny had put together a guidance sheet for those called upon to advise consumers in cases of freezer breakdown. Step one, interestingly, is to find out how long the customer has had a freezer, on the basis that "those who have had one less than one year may be inclined, quite understandably, to panic; those who have owned one for longer will, by experience, know better what to expect of frozen food and its behaviour" (Webb 1984).

A freezer breakdown need not be a disaster, they reassure readers. People's fears about frozen food suddenly becoming unfit to eat are rationalised by drawing comparisons with what happens when frozen food is thawed intentionally. Thawing is a gradual process and they stress how long things take to thaw, even when one wants them to! This means that an accidental, short-term interruption need not necessarily be a problem. Designed to be well-insulated, freezers can maintain low a temperature for a short period, even without power. So long as the freezer is kept closed to prevent warm air entering, it can maintain sufficiently cold temperatures for up to eight hours. A power outage for part of a day may make very little difference to the state of food inside the freezer, especially if it is well stocked. Even after long periods with no electricity, "all is not lost" reassures Webb. "All the food does <u>not</u> suddenly go bad" but will begin to thaw as normal. Different types of foods thaw at different rates, giving the user a window of opportunity to deal with them in the case of an extended breakdown. Cautioning against panic and waste, she reiterates her point that "there is rarely any need for panic action such as throwing it all away!" (Webb 1969, p. 3). She explains that if frozen food is thawed, intentionally or not, it may safely be refrozen while still frosted if still hygienically packed. Some foods remain palatable longer than others. Raw fish spoils quickly so cooking before refreezing can be sensible, whereas things like bread and cakes can simply be refrozen. If preferred, thawed products can be cooked to destroy any bacteria, after which is it safe to refreeze. If a freezer is out of action for some days, then obviously foods will start to go off, but Jenny reassures consumers that, should it reach this state, they will be able to tell from its smell or appearance if food is no longer good. The guidance sheet for those responding to consumer queries advises them to tell users (who are assumed to be almost exclusively women) to use:

> their common sense and knowledge of the signs of freshness in food to decide what to keep, use or throw away. … [If] in any doubt at all about an item of food, then she should discard it, on the principle of being better safe than sorry. … The final decision should always be made by the owners of the freezer, as they alone know the history and condition of each item of food (Webb 1984).

Should the technology fail, these women are to fall back upon their own sensory and experiential knowledges. In contrast to much of the advice with which she has been issued, here the housewife is encouraged to rely techniques of looking and smelling because she alone carries the knowledge of the journeys taken by individual foodstuffs into individual freezer cabinets; only she really *knows* that freezer and that food.

A LACK OF REFRIGERATOR KNOWLEDGE

As refrigerators grew more pervasive, it was easy for manufacturers and others to assume that 'everyone' knew all about fridges and food storage. Jenny remarked to me that that now that almost everybody has a refrigerator, there is a risk that "we can all get a bit casual about it." In a 1990 text referring to a peak in food poisoning levels the previous year, she made the observation that "recent events indicate that there is a tremendous lack of knowledge with respect to food hygiene and storage" (Webb 1990). Despite their ubiquity, despite their familiarity, despite the years of instruction leaflets included with new fridges, it seems that contemporary refrigerator knowledges are much poorer than might be expected.

Home-prepared food is a major source of foodborne illness. Consumer surveys repeatedly reveal high numbers of people who fail to store food correctly and lack awareness of the dangers of food being kept at too high a temperature or left too long before consumption (MAFF 1991; IFT 1995; FDF 1996). A survey of 252 British households, conducted by the food research division at Bristol University on behalf of MAFF in 1991, found that the temperature of chilled foods rose dramatically on their way home from the supermarket and that when they were put in the fridge, pull down times could be several hours (Evans *et al* 1991). Survey participants did not understand the importance of using their control dial to lower the cabinet temperature and the study drew attention to the need for improved consumer education, suggesting that users be given more encouragement and guidance, both during the purchase of a fridge and in the accompanying information booklet. Possible strategies debated within the industry have included a return to more detailed instruction handbooks that cover food purchase, storage and refrigerator care. Jenny explained that in the past manufacturers supplied combined instruction/recipe book with refrigerator purchases, the rationale for including recipes being to ensure that people kept the book because “this way the manufacturer has a method of sustained education.” However, cost-cutting exercises saw these shrink into small leaflets containing minimal information.

A prime problem is a lack of knowledge about the temperature at which their refrigerator is, or should be, operating (Spriegel 1991; Evans *et al* 1991; Walker 1996). Periodically, public education campaigns have taken place to try and improve awareness. ‘The Big Chill’ was a campaign launched by the Electricity Association in 1992 to highlight correct temperatures for safe food storage after a market research survey on public use of and knowledge about refrigeration revealed that 86% of people did not know the correct operating temperature for a fridge. Initiatives continued the following year with a Chilled Food Association (CFA) food hygiene campaign to encourage consumers to manage their fridges correctly. The CFA developed a ‘fridgeometer’, which it distributed to promote awareness of correct fridge operating temperatures for food hygiene. “The launch of the CFA fridgeometer follows an earlier MORI survey, commissioned by the Food and Drink Federation in conjunction with the Institute of Environmental Health Officers which showed that 73% of households do not have a fridge thermometer and 9 out of 10 people did not know the recommended temperature for their fridge. Furthermore, of the one in four who thought they knew, half were wrong" (CFA 1994).

Johnson *et al*'s (1998) study of food storage knowledge and practice among 809 elderly people living independently in their homes concluded that storage practices for the majority of their participants did not meet recommended standards for food safety and put them at an increased risk of food poisoning (1998, p. 747). Of the 645 refrigerators they tested, 70% were found to be running at temperatures of 6°C or above, which is too warm to assure safe storage. Hudson and Hartwell (2002) also examine food safety issues among older people living at home and draw attention to the significant changes in food technology and shopping practices their participants experienced during their lifetimes. In common with earlier studies, most of their participants did not know the temperature of their refrigerator. Once again, this suggests that refrigerator knowledges might not be as 'obvious' or represent such 'common sense' as my interviewees suggested at the beginning of this chapter. The risks associated with higher fridge temperatures can be ameliorated when shopping is done frequently and there is a rapid turnover of food. However, as I explain more fully in the next chapter, the general tendency has been towards less frequent food shopping and longer storage times. I flesh out some of the changes in technology and practice that occurred within participants' lifetimes as refrigerators were domesticated into people's homes and took on a central role in their daily lives.

Chapter 5

Living with a Fridge

This chapter turns to practice and takes as its focus the 'spatial stories' of a collection of refrigerator practices (de Certeau *et al* 1994, p. xxxii). I ask what happened when refrigerators moved into British homes and settled in to become a 'normal' component of the kitchen. I begin before the fridge arrived in order to examine how people managed their food before refrigeration was domesticated and to trace how its introduction reshaped daily practices of social reproduction. The first section looks at shifts in people's shopping and provisioning routines, eating habits and storage methods and from here I move on to some of the ways in which relationships with food have been remade, specifically through packaged foods and date stamps. These technologies comprise part of a broader system of industrialised food production and global transportation, whose introduction contributed to new understandings of food safety and freshness.

From an engagement with food items directly, I then look at how the refrigerator itself is negotiated as a shared social space by considering the coexisting and sometimes conflicting 'rules' of food storage and the way household members engage with the refrigerator as a social object. Just as Hand and Shove (2007) analyse different ways of living with a freezer, so there are many ways of living with a fridge. Innovations in refrigerator 'work,' but also refrigerator 'play,' generate what Shove (2002) would term 'proto practices,' some of which go on to achieve a level of stability as widely accepted and routinsed practices. In this way, fridges have evolved multiple roles and I consider the phenomena of the 'fridge door' as a site of communication and display.

Once refrigerators started to be viewed as an essential household item, civilised living began to seem unthinkable without them. In contemporary Britain, the idea of living without a fridge is one that few people would contemplate by choice but I close the chapter by turning to two families who decided to do just that. I discuss their food storage strategies and ask how such practices are viewed, now that refrigeration is unquestionably the 'norm.'

DOMESTICATING COLD

Artificial refrigeration was hailed as a way of making cold docile and dependable (Grahame, 1994). Just as the 'domestication' of wild plants and animals signifies a degree of mastery over 'nature,' so the refrigerator brought with it the promise of being able to intervene in the order of things to control the vagaries of temperature, climate and season and create 'winter' on demand. As a 1930s Electrical Development Association handbook put it:

> Nowadays snow is at hand even in summer. … It is tame snow, but dependable. You can do everything with it except ski. It knows its place. It is snow with work to do (Simpson c.1930s, p. 5).

Its place was in the kitchen and its work was to provide consistent year-round cooling. Furnival characterises the 1930s as the time when the fridge first becomes "house-trained" and, thanks to the replacement of ammonia with Freon and the development of thermostat controls, evolved from "smelly beast" to "kitchen pet" (1998, p. 65). As objects and technologies settle into people's homes and lives, they start to seem like 'part of the furniture'; some are even anthropomorphised and regarded as 'servant', 'family-member' or 'friend' (Habib & Cornford 2002, p. 167). Dorothy Ladd was very sad when the time came to say goodbye to her "faithful" but elderly refrigerator after "forty years good service," and, even after just a short trial period, Finn Anderson, a participant testing one of Electrolux's Screenfridges in a Copenhagen suburb, said that "it'll be like they are taking away a good friend," when the company came to retrieve it (Echikson 2001).

As we saw in Chapter 3, mechanical refrigeration for the home was first developed in the mid 1910s, but widespread ownership did not occur until the 1930s and 1940s in the United States, and considerably later in Britain. Along with the car, the refrigerator came to play an important role as a vehicle of postwar suburbanisation.[49] The landscape of the American suburbs is built, in part, upon its domestication, for it was the capacity to maintain a comprehensive stock of food at home that made possible a pronounced spatial separation between residential and retail functions. Refrigerators, cars, supermarkets, electricity

49 The connection between the two is particularly pronounced in the case of General Motors, who put the Frigidaire refrigerator into mass production adjacent to its car assembly lines.

networks, central heating, mortgage finance, low density housing and ideologies of gendered domestic practice were interwoven to create a sociotechnical infrastructure that redrew spatial relationships between suburban dinner tables and the sources of the food upon them, as well as reconfiguring practices of social reproduction (Spain 1992; England 1993; Neuhaus 1999; Hayden 2004). The car-refrigerator-supermarket nexus clearly underpins the Philco advertisement below (Figure 5.1). Describing its refrigerators as "custom designed for the modern trend of buying foods ahead and storing them in volume," the company promotes these appliances as technologies facilitating the adoption of this new and modern practice.

Figure 5.1 Philco advertisement, *Ladies Home Journal*, 1950

Together, the main image and the line drawing below reinforce the classed and gendered ideal of the car-owning suburban nuclear family who shop in bulk at supermarkets, transport their groceries by car and maintain an ample supply of fresh and frozen foods at home. A shopping expedition to fill the fridge is depicted as a family affair in which women take responsibility for stocking and managing the refrigerator and men for loading and driving the car.

Brought into the home, incorporated into daily life and socialised to perform a particular role, refrigeration shifted category from ‘novel’ to ‘normal’ and from ‘luxury’ to ‘necessity.’ What constitutes ‘necessity’ is contextual and culturally specific. As Pantzar (1997, p. 52) observes in the case of the car, by the 1910s it was already considered a necessity in the United States, but was not in Finland until the late 1960s. Adoption of refrigerators started slowly in Britain. Manufacture was interrupted by the Second World War and the redirection of industrial capacity to the war effort, but in the 1950s, the number of refrigerators in British homes increased with the lifting of postwar credit restrictions. Ownership accelerated in the 1960s, but it was really only at the close of the 1960s – a time when central heating and, consequently, ‘room temperature’ were on the increase – that refrigerators became commonplace in Britain[50]; in 1956 just 8% of households had a refrigerator, rising to 23% in 1961, 73% in 1972 and 99% by the late 1980s (FFRC 1974; GHS 2002).

There is no inevitability about the success of new products and the point is often made that most new items introduced onto the market fail. Nevertheless, once new technologies do get incorporated into household routines and rituals, they bring different ways of doing and different ways of thinking. Silverstone and Haddon (1996) describe the process of domestication as an ‘articulation’ to emphasise the *mutual* adjustment that takes place. In the process of adopting a new product, users adapt them in often subtle ways to fit their spaces, needs and habits. They also adapt *to* them, configured by ‘scripts’ that invite them to behave in certain ways (Akrich 1992; Woolgar 1991). An advertisement for Philips’ freezers in the July 1976 issue of *Good Housekeeping*, promotes the adaptability of its freezers as a key selling point. “Philips don’t expect you to adapt to your freezer. Your freezer should adapt to you,” it reads. Below are two images, one showing an upright freezer with five drawers neatly stacked

50 In Frances Soar’s (MMB) opinion, “central heating was the big thing that changed our lives. … We then had to get a fridge, which we hadn’t had before, because the food started going off in the pantry.”

with packages frozen food, the other showing the same freezer with all the drawers removed to make room to hang half a carcass. Although the implication is that the appliance will be doing the adapting in order to accommodate its user's needs and preferences, in practice people invariably adapt their own habits and behaviours to a degree. For instance, research was undertaken by the Research Institute for Consumer Affairs to investigate how refrigerators might be more effectively designed to suit the needs of disabled housewives. The Institute's conclusion was that "these studies were less productive than we hoped. We found most of the housewives had adapted themselves and their actions to the peculiarities of their refrigerator" (RICA 1969, p. 1).

Though never deterministic, these scripts can be persuasive. Steered to perform in certain ways through the 'prescription' of certain behaviours (Akrich 1992), and 'placed' in domestic space, users may find themselves domesticated by their own machines.[51] Literature and resources dealing with household organisation are aimed predominantly at women. Silva demonstrates how scripts in cookbooks and instruction manuals reinforce feminine identities but also affirm domestic space as the appropriate location for both the object and the user (2000, p. 615). Likewise, early refrigerator handbooks explicitly addressed women, assuming them to bear responsibility for cooking, food safety and family health (Frigidaire 1928; GEC 1932; BTH 1943). That is not to say that men do not do housework or worry about domestic order, but running a home has long been bound up with the construction of feminine identity and the two become difficult to disentangle. Gender is not an inherent property of things but objects associated with certain tasks often start to carry normative gender messages, produced in part through the normalisation of assumptions about women's and men's use of objects and technologies.[52] When asked in a 1991 Mass-Observation survey on 'New Technology' which piece of equipment had made the greatest difference to their own or their parents' lives, the refrigerator was participants' second most common choice (after the washing machine, credited for removing the heaviest component of household drudgery). One participant wrote:

51 Of course, this process is not always smooth. Technologies can be resisted or rejected. See, for example, Lally (2002) and Habib & Cornford (2002) on anxieties about and resistance to the domestication of the home computer.

52 Historically located and relational, the gendering of objects can change, as in the microwave's translation from a 'brown good,' a predominantly masculine hi-tech gadget, to a 'white good,' a primarily feminine domestic appliance (Ormrod 1994, p. 45-7).

> My parents probably found their fridge the biggest release. It saved my mother from the need to shop every day and also from the various time-consuming methods of keeping food fresh.[53]

While refrigerators did transform certain aspects of women's lives, and reconfigured domestic spaces and food storage, gender divisions proved more resilient, with the effect that provisioning, feeding and caring work remain strongly coded feminine (DeVault 1991; Silva 1999).

Mechanical refrigeration offered a way to control time and tasks as well as temperature (Shove & Southerton 2000). As I show in this chapter, it displaced a range of place-specific temperature management methods that were sensitive to local variation. Cooling instead became a centralised and standardised practice, sustained year round and largely independent of the skill of the user (Grahame 1994). The temporal and spatial reorganisation of cooling reconfigured kitchen spaces and provisioning practices. Pantries and larders were largely superseded and daily grocery shopping dwindled in favour of a weekly one-stop supermarket shop. Growing car-reliance, supermarket shopping and increased availability of frozen, chilled and processed foods were bound up in new eating and provisioning patterns. 'Food miles' – the distance that food travels from producer to consumer – increased with the availability of technologies for prolonging the shelf life of perishables and transporting them around the globe. Between the early 1980s and the mid 1990s, the distance food was transported increased by a third (Paxton 1994). There was also an associated redistribution of expertise relating to food preservation and storage. While the means of making cold was widely distributed across individual homes, sources of expertise were relocated from individual users (mainly women) and increasingly centralised within official bodies. Responsibility for processing food, for judging durability and determining the appropriate handling of food were being delegated to someone else, somewhere else.

By seeping into expectations about basic living standards, objects like refrigerators become constitutive of domesticity and serve as revealing measures of how constructions of domesticity have changed (Silverstone and Hirsch 1992, p. 6; Morley 2003). Another Mass-Observation survey participant made the observation that:

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53 Response to Question 6 of the Mass Observation Autumn Directive 1991, Part 2, 'New Technology,' survey participant A1473, female.

> Like the washing machine and dryer, the fridge is the latest in a succession of similar machines. All are necessary to family life so far as we are concerned (MOA 1991).[54]

This implies that a family cannot adequately perform ‘family’ without a fridge. Once settled in the kitchen and integrated into daily routines, refrigerators become normalised as unremarkable and taken-for-granted appliances. This normalisation is evident in responses to the Mass Observation survey and is most clearly seen in one respondent’s apparent hesitation over whether the refrigerator should even be listed of the technologies in his home. In the end, he added the fridge, but qualified its inclusion with a note in brackets saying “normal equipment.” His struggle over whether the fridge could be considered sufficiently ‘novel’ or ‘hi-tech’ positions the fridge as something so ‘ordinary’ it barely counted as ‘technology.’[55]

PRE-FRIDGE STORAGE AND FOOD MANAGEMENT PRACTICES

In my conversations with interviewees, people mentioned a range of strategies for storing and preserving food, both inside and outside the house, before they had refrigerators. Nancy described the big walk-in larder in the corner of the kitchen when she was growing up, where food was cooled by a large marble shelf and an air vent on the outer wall. Houses were usually built with a larder and these were most effective when located in the northwest corner, for this tended to be the most exposed to wind and rain so offered the coolest aspect. Mike McFadyen, an electrical engineer and appliance repairman, extolled the design of the British larder window. A fixture let the window drop open to draw in air and, because the opening was too small to allow anyone to climb through, the window could safely be left open all the time. Some larders were like small storerooms or large walk-in cupboards. In Ruth Hägen’s late nineteenth-century terraced house in Oxford, the larder took the form of a ventilated dresser built into the structure of the house (Figure 5.2). A few of the bricks from the outside wall, which forms the back of the dresser, were replaced with metal grilles to create air vents at the rear of the cupboard.

54 Survey participant B1654, male.

55 Survey participant B1509, male.

Figure 5.2 Ruth's built-in ventilated dresser

Source: own photograph

Though common, larders were not found in every house. Nancy's husband Geoff explained how his family kept food without one:

> Geoff: When I was in London we used to have a pantry, well I call it a pantry, it wasn't a pantry it was a cupboard in the hall. There was a coal cupboard where all the coal was kept and next door to it was where we kept any food, things like evaporated milk or sugar, solid stuff, and then out in the garden on a kind of stand was a kind of box.
>
> Nancy: Like a rabbit hutch.
>
> Geoff: It was made of wood and the front had a gauze on it, a kind of metal gauze, and you open the front and there were shelves inside and the milk and the butter went there. That was in the garden. You went outside and got the milk. And that was all there was, a gauze keeping things cool because you couldn't keep it in the house, the house was always too warm for your milk. Sometimes in the bottom you'd have some vegetables, or anything that was likely to go off in a couple of days.

Elsie (MMB) still lives in the same house in the mining town in Gloucestershire where she grew up. Her family kept most food in a large pantry with a built-in meat storage section made from galvanised perforated zinc, the 'gauze' that Geoff mentioned on his meat safe. She described storing butter in a dish that was placed in a shallow bowl of water under an upturned flowerpot and explained how the porous earthenware pot absorbed the water and kept the butter cool as it evaporated. Certain foods would be distributed elsewhere around the house: flour, sugar and other goods that needed to be kept dry went on the shelf above the mantle; onions and sides of bacon were hung from hooks she still has in her ceiling; potatoes went in the wash house to keep them free of frost in winter; and any surplus eggs were preserved in isinglass to tide the family over when the chickens stopped laying in winter. Janet Cooper remembered the pantries, the marble slabs and the meat safes but also recalled some creative instances of improvisation, like the neighbours who kept butter in a small wooden box which they hung out of the window, or the ninety-five year old man next door who, until he got his first fridge just a year or two ago, kept his milk in a wide-rimmed bottle suspended on a string down his well.

Milk was a recurring topic of discussion and many people talked about the daily door-to-door milk deliveries by horse and cart, and later by van. As a child in the 1940s, when Janet heard the cart approach she would rush outside with a gingersnap to feed the horse and carefully carry the pail of milk inside. As Gwen explained:

> In those days the milkman didn't come round to the door like they do today with bottles. He came round with a whole churn of milk and you went outside with a jug and said 'can I have a pint of milk please.'

Despite being delivered daily (and in some places twice daily, after the morning and the evening milking), preventing milk from spoiling could still be a challenge. Gwen said her mother kept milk in a bucket of cold water outside the door. At one point she remarked that "nobody worried about whether it was hygienic or pasteurised or sterilised or whatever, like we do today. And we're no worse off for it, are we Iris?" However, milk generally received more sophisticated treatment than Gwen had remembered. It was only when Iris began sharing vivid memories of her mother boiling milk and letting it cool that Gwen was reminded that 'do-it-yourself' sterilisation had, in fact, been common practice. Elsie described the process:

> You always scalded your milk when it arrived in the morning, which is basically what pasteurised milk is today. You raised it up to not quite boiling point, put it in a jug and covered it with cloth with beads around it to keep the flies off.

In these descriptions of food preservation sites and strategies, I want to draw attention to two things. First, the apparent ordinariness of these routine practices makes it easy to overlook the technological knowledges upon which they were based. Processes of scalding and evaporation, and objects like earthenware pots and beaded cloths, were all simple but effective 'technologies' for killing bacteria, removing heat and creating barriers to prevent contamination. The second point concerns the spatial reorganisation of preservation methods; for instance, commercial pasteurisation involved shifting the location of and responsibility for sterilisation from the home to the dairy. With domestic refrigeration, a range of preservation methods which had formerly been distributed through people's homes and gardens were gathered together, brought into the kitchen and contained within a box.

Sharing food and building social networks

With limited facilities for storing perishable foods, the main ways of minimising waste were to use food up quickly, to preserve it using methods such as pickling or bottling, or to share it with others. It was emphasised repeatedly that few could afford to waste food and that any surplus would be given away rather than thrown away. Older interviewees repeatedly talked of there having been a much stronger culture of people helping one other out in this way when they were young. Mary Forster (MMB) remembered the owner of a string of grocery shops, appropriately a Mr Goodfella, giving food parcels to her family because he knew her father was out of work. Similarly, Alice Poutney's (MMB) butcher passed any leftover meat he could not keep to families in need. Everything in the kitchen and garden would have been used and nothing wasted, Alice stressed, so any gluts of home-grown vegetables might be given to local families without a garden. Before the creation of the welfare state, this kind of neighbourliness and mutual reliance was crucial for many people's survival. In this way, social ties were reinforced through sharing food, a practice intimately connected to the food preservation methods then available.

One unintended effect of widespread refrigerator ownership was to disrupt these networks of reciprocity. This was articulated most clearly by Efia in her observations about changing technologies and social relations in her native Ghana. To her, having a fridge meant no longer having to share. She couched the change in positive terms as bringing users greater independence and cost savings:

> Now people can slaughter a goat, whereas before they were forced to share with others, because there's no fridge. It's too much if you buy one sheep or a lamb …. You can't consume it all. [People] pooled

> together to buy one goat and share the cost. But now one family can just buy it and use it or sell the rest, … saving you money.

No longer needing to rely upon others, a fridge grants owners greater freedom in what they can buy and when. Of course, access to this technology requires a certain level of wealth and Efia acknowledged that the availability of refrigerators did not benefit everyone. Those who could not afford refrigeration remained unable to store meat for long but their disadvantage was compounded because they now had a smaller pool of people with whom they could potentially share, "because if you have a fridge you're not going to share with anybody anymore. … I think now it is an advantage with a fridge. You can keep it to yourself and you do not have to ask people." In this way, a refrigerator buys independence and self-reliance, though maybe at a cost of increased social distance.

A rhythm to the week

I had expected to hear accounts of different temporal rhythms existing prior to domestic refrigeration but the narratives I had anticipated were about seasonality, about various vegetables being associated with particular times of year, or perhaps reiterations of the rule to eat pork only when there was an 'r' in the month on the basis that it did not keep well during the summer months. More unexpected was the very pronounced weekly rhythm of domestic practice and consumption that older interviewees described when they were growing up. Certain tasks and certain kinds of food were associated with certain days. Iris, like most of her contemporaries, became immersed in a weekly routine that soon became taken for granted. "You had a special day for every chore," she said. "We didn't know any different." Time and time again I was told that Monday was always washday. In Iris's household, Tuesday would be ironing, Wednesday the day for cleaning the upstairs rooms, Thursday the downstairs rooms and Friday would be bath night. Similar patterns were replayed each week in homes throughout the country.

Frances Soar (MMB) felt household organisation had changed a lot during her lifetime and commented that it was now rare for people to have a regular washday. In an observation which echoes Cowan's thesis about 'advances' in domestic technology creating *More work for*

Mother (1983), Frances noted a certain irony; “my mother always used to wash on a Monday and iron on a Monday evening and that was it for another week, whereas now, with all these labour-saving washing machines, we wash every day so there’s always ironing to do!” She did not dispute that the work of doing laundry was more physically demanding prior to the washing machine, but she saw some advantages to having a designated day each week to keep the task ‘contained.’ With the freedom and flexibility to wash at any time comes a tendency for it to spill throughout the week.

Just as there was a weekly pattern for household chores, so there were conventions for having particular meals on particular days. Anchoring the week for many Britons was a traditional Sunday roast.[56] In June Care’s household (MMB), Monday’s meal was called ‘the resurrection,’ that is, Sunday’s leftovers reborn as some kind of pie. Gwen pointed out that meals on Mondays were always something quick and easy like cold meat “because Monday was washday, always.” Typical meals for my interviewees were things like stew on Tuesday, mince on Wednesday, chops on Thursday and fish on Friday, followed perhaps by tripe and onions on Saturday, though in Gwen’s case meals were much less varied and they mostly lived on casseroles. In Frances’ home in the 1950s and 60s:

> We always had a roast on Sunday and then you ate it up in the week. So it would be cold meat and leftover vegetables on Monday, probably a bit more cold meat on Tuesday, then the roast was getting down to the last bit for mincing and by Wednesday you were getting on to the hash and Shepherd's pie, ready for fish on Friday.

This pattern seems to have been remarkably consistent across the classes. Geoff’s family struggled financially when he was a child. His mother took in washing and the children were expected to help out to make ends meet:

> I have to say we lived very meagrely. I mean, three slices of bread and half a cup of tea was your tea. There wasn’t a great deal of shopping done. … If my mother went shopping at all she would go Saturday evening late because butchers were selling off their stuff cheap, as they had no way of keeping it, … so she’d get bargains. Whatever else, we always had a roast on Sundays. My father *insisted* on a roast.

56 Although this was the dominant convention, it would not have been universal for eating practices vary between different cultural groups.

To his father, part of being a respectable family was keeping the tradition of having a roast dinner on a Sunday, however limited their fare the rest of the week. Florence Wadlow (MMB) spent many years in service as a cook at Blickling Hall in Norfolk for the Marquis of Lothian. Even in this very wealthy household, eating habits were not as different as one might expect. As Florence explained, “we'd have a joint of some kind on a Sunday, cold meat on a Monday, perhaps done up in a cottage pie the next day.”

Patterns of provisioning: buying little, buying often

This distinctive rhythm to weekly meals was born out of the limited shelf life of perishable food. “You did your shopping every day because nothing would keep. I mean, you couldn’t keep meat unless it was cooked,” said Iris. With care, a roast could be stretched over a few days but, without the capacity to maintain a large array of perishable foods at home, people shopped regularly and consumed food quickly before it went off. Gwen also emphasised an important shift in cultural norms around the whole question of food ‘storage.’ Food wasn’t bought to be stored but *used*, she stressed, pointing out that “you just bought something and used it til it was finished”.

Two clear patterns emerged from the accounts of interviewees in their fifties and above. The first was of grocery shopping being done virtually every day. “You didn’t just go for one huge shop once a week,” explained Elsie, “you popped out in the middle of the week so you always had fresh food.” A dominant memory for Mike was of people shopping “all the time. … My mother shopped *every single day*,” he stressed. This leads us to the second trend, which was that this shopping was done almost entirely by women. “The man expected to earn the money and the wife to look after the house,” Gwen explained. Iris added: “My father, I can never ever remember him doing the shopping. I mean, he was waited on. He was the head of the household.” Her mother did a big shop each weekend, a process that involved three or four separate journeys and took up most of her day. “That’s all she’d do!” Iris exclaimed. Meat would be first because “that was the most important thing.” Greengrocers always tended to be located next door to butcher shops, so after buying meat and vegetables on one trip, her mother would bring them home, and then go out again to the baker and the grocer and so on.

These interviewees grew up in a context of firmly established gender roles where the feminisation of domestic responsibilities was rarely questioned. Food shopping was an activity strongly coded feminine, though its gendering was more fluid in the case of children, for boys as well as girls were sent on shopping errands. Buying groceries was one of Mike's childhood chores. Similarly, in Gwen's family, it was her brother's job to go shopping in the mornings before school, until she inherited the task when he started work. Although boys may have bought groceries, and occasionally husbands too, their participation was generally framed as 'helping' their mothers or wives, with whom overall responsibility for shopping remained. Lack of cold storage necessitated almost daily shopping. When Gwen and Iris, both from working-class backgrounds, got married and left home, each had a job in addition to her domestic duties. When I asked how they coped with shopping, cooking and housework as well as full-time jobs, both stressed that women planned their weekly meals in advance in a way that is uncommon today. In Iris's words, "you didn't get to the shop and go 'what shall I get for dinner?' You planned that out beforehand." Frances commented that "it must have made planning an awful lot easier, because … you knew what you were going to have." Although the weekly cycle of meals sketched out in the section above would now strike many people as repetitive and dull, some saw advantages in such predictability. Sticking to a well-worn weekly structure helped lessen the work of food management by removing the pressure of deciding what to cook for family meals day after day, something a number of women I interviewed found increasingly burdensome. Here, not just the work of feeding, but also the 'work' of deciding, falls to these women in a domestic division of labour that is cognitive as well as physical:

> In the supermarket, the housewife confronts heterogeneous and mobile data – what she has in the refrigerator, the tastes, appetites, and moods of her guests, the best buys and their possible combinations with what she already has on hand at home, etc (de Certeau 1994, p. 6).

In contrast to contemporary habits, people bought food in much smaller quantities. Speaking slowly and laying stress upon each word, Iris explained, "you didn't buy in bulk. You bought what you needed." As Ruth Hägen, an economic historian, pointed out when we spoke, the practice of buying little and often was also reflected in the fabric of the urban landscape:

> I think we have to remember that people shopped every day here. You didn't have a need for the fridge. You would buy milk every day. You would buy butter every day. You would just get a small pat. These tiny shops, they'd be on, you know, every street would have one. You'd walk down any of these old

> streets and you can see the houses that were once shops. … We think that we're an incredibly commercialised society now, overwhelmed with shopping, but it's always such a wonderful thing to tell my students that there were more shops per head in the eighteenth century that there are now. But it was a very different kind of shopping. People didn't go out and do their huge Sainsbury's shop, the shops weren't huge, vast sort of places.

People bought food, ate it within a day or two, and then went out and bought some more. In addition, for many people food was not simply something that they bought, but also something that they gathered, grew or raised. The generations that lived through the depression years of the 1920s and 1930s learned to be thrifty to survive. With food shortages during the Second World War, and rationing continuing for almost a decade after it ended, people were forced to get creative with their food sources. The 'Dig for Victory' campaign encouraged Britons to turn their gardens over to growing food to help the war effort and vegetables and fruit could be scarce for those without a garden or allotment to grow their own. Interviewees like Nancy and Brenda who lived in rural areas, but also many people in urban and suburban areas, grew their own vegetables and raised chickens for eggs and meat. During the war, Elsie's family had a pig and bred rabbits and June Care's family relied heavily upon her father going fishing and the children going shrimping or following the tide out to gather mussels and cockles.

However, many interviewees who had been used to growing their own food for most of their lives found it hard to maintain their vegetable gardens as they aged. Until a heart attack prompted him to retire from work and radically scale back his gardening, Ronnie Porter used to have two greenhouses behind the house and a vegetable plot down the street. Although he no longer grows vegetables, Ronnie still has working dogs and regularly goes shooting. He takes some of the pigeons and pheasants he shoot to a local dealer and others he plucks, dresses and freezes for his own use. In short, many of my interviewees had provisioning patterns in their early lives that are increasingly uncommon in Britain today. Fewer people grow their own food than did a generation or two ago, and even fewer raise or catch their own food like Elsie, June or Ronnie. On the whole, people's diets are now more varied and, thanks to technologies of transport and preservation, the geographic origins of the foods they eat are more far-flung, but the ways in which people source their foods have become much less diverse.

The changing shape of shopping

Refrigerator handbooks counselled readers on the benefits of altering their shopping habits. "First of all you must revise your ideas about shopping," a 1943 BTH handbook instructs housewives, telling them it is "absurd" to continue buying food in small quantities. Instead, it recommends planning ahead and making a single trip: "lay in your stores and let your refrigerator look after them" (1943, p. 4). A GEC handbook from the same year emphasises the many journeys to market a refrigerator can save by enabling the housewife to buy in larger quantities when prices are low because she can be confident that her refrigerator will keep food fresh for several days. To illustrate how much shopping had changed in her lifetime, Elsie described accompanying her mother on the weekly trip to the Co-op as a child in the 1930s. At that time, customers did not gather items from the shelves themselves. Instead, her mother would sit in a chair beside the counter and a shop assistant, "a young man in spotless overalls," would take her order, first slicing the bacon, then weighing the butter and then measuring out the dry goods and wrapping and packing everything for her. The box of groceries would be delivered to their door the following morning. A range of other food retailers, such as butchers, fishmongers and bakers, also delivered orders or sold door-to-door by van. Doreen Knight did not recall her mother, who was disabled and had difficulty walking, ever going shopping; fortunately, the extent of home delivery and sales was such that she was able to buy most things at the door.

Significant shifts in grocery shopping were taking place by the late 1950s and early 1960s, with a shift to self-service stores, as charted by Boyd and Piercy (1963). They estimate that fewer than one thousand of such shops existed across Britain in 1951. This figure grew ten-fold within the next decade and by 1962 one third of all grocery stores were self-service. Such rapid growth attests to their popularity, at least among certain social groups. However, 'self-service' had low status in some people's eyes so there was resistance to this trend from those like Elsie's mother for whom service culture remained important and carried social prestige (Boyd & Piercy 1963, p. 32). Interviewees talked a lot about the individual stores – the butchers, greengrocers, dairies, bakers, tobacconists and sweetshops – where they used to shop. By the early 1960s, a process of horizontal integration was bringing products previously sold by different retailers together under one roof. Smaller, specialised and family-owned stores started losing out to the larger general grocers and, in turn, co-operatives and independent grocery stores struggled in the face of growing competition from supermarket chains (Boyd & Piercy 1963, p. 30-33). Between 1957-61 sales across all retailers increased by an average of 15%, but breaking this figure down reveals that the independent grocery sector rose by just 11% in contrast to the multiples, whose sales increased by 29% over the same period (p. 31).

The 1960s saw grocery multiples manoeuvring into a more dominant position. Lois Carnie (MMB) remembers visiting the very first supermarket to open in Edinburgh. She found the experience “mind-boggling,” and described the place looking more like a warehouse than a grocery shop. Word circulated about these novel retail outlets and curiosity grew. In Frances’s case, her very first exposure to the supermarket came via children’s literature. As a child in the 1950s, she read a series of Canadian books about the Bobbsey Twins and recalls being very impressed that their family shopped in something called ‘a supermarket,’ at that time a strange and exotic-sounding place. Thus, even children’s stories travelling from overseas can bring new knowledges and provide an insight into daily practices commonplace elsewhere but as yet unfamiliar in Britain. Boyd and Piercy estimate that in 1957 Britain boasted around 80 supermarkets, a figure that would leap to 750 in the next four years. By 1962, Tesco had 30 stores and plans to add another dozen by the end of the year, London Grocers was intending to double its chain of 42 stores within the next couple of years and Premier to increase from 29 to 70 stores. Associated British Foods had already built up a chain of 200 supermarkets, though significant regional disparity existed in this early phase, with more than half of all supermarkets located in the London area (1963, p. 32-3). In Britain, the number and size of supermarkets grew much more slowly than in the United States. Boyd and Piercy attributed this to three things. First was the comparatively low level of car ownership. Although figures were rising, they saw high taxes on cars, fuel and road construction as a major disincentive to adoption. So long as food shopping was mostly done on foot, or by public transport, there was a limit to how far people were willing or able to travel and an increased likelihood that many would continue shopping at smaller retailers closer to home. A second factor was the density of development in urban centres. Land for building expansion or for car parks was more limited, and therefore less affordable, in British cites than those in the United States. Thirdly, they looked to the kitchen for explanations. British kitchens were compared – unfavourably – to their American counterparts. Boyd and Piercy pointed in particular to "the small amount of storage space in British kitchens which, with the general lack of refrigeration, requires the housewife to make frequent shopping excursions" (1963, p. 33).

Today, Frances considers the supermarket to be an integral part of her life. She enjoys the convenience of being able to shop infrequently and has no desire to go back to using individual stores. Food Standards Agency (FSA) research indicates that supermarkets now represent the primary site for grocery shopping for 95% of the British population (FSA 2004). The supermarket came to be regarded as something utterly ordinary and, for most contemporary Britons, the idea of shopping at small stores is now the novelty. Older interviewees shared the view that the emergence of the supermarkets altered the way they shopped and ate, most notably in the variation in their diets and the scale and frequency of their shopping trips. Taught that buying food in bulk and storing it at home was both modern and convenient, the majority enthusiastically adopted 'one stop shopping.' Marianne Emery commented:

> Now you drive to the supermarket and you see people with their trolleys stacked high, so of course they need the space when they get home, they need the fridges and freezers. It's got to do with high street development.

For her, the cultural shift to shopping by car in out-of-town supermarkets, rather than at "little shops around the corner," elevated the importance of the refrigerator because consumers need access to ample cool storage space when they shop more infrequently and in larger quantities. In her mind, connections between household technologies and retail landscapes were clear. She pointed to similar trends in Britain and in Sweden and talked of big stores "taking over" and high streets "dying." There used to be three grocery stores, one shop that repaired shoes and bicycles, a butcher's shop and a dairy in the village where Mary Trett (MMB) lives, all now gone save for a general store and post office. "It's a great pity people now go off to supermarkets to stock up," she commented. In Geoff's case, his village has been left with no shops at all. Unable to compete with the chains, they lost local custom and one by one closed down. The growth in supermarkets, particularly the larger out-of-town stores, was facilitated by, and becomes difficult to disentangle from, growth in both refrigerator and car ownership.

Like any practice, though, supermarket shopping is never uniform. The fact that some shoppers overload their trolleys, cars and fridges, does not mean that everybody does. Exceptions include people like Gwen, Iris, Dorothy and Elsie all, of whom have altered *where* they shop more than *how*. These women get most of their groceries from supermarkets, but rather than stocking up in bulk, each maintains the habit of only buying what they need for a few days at a time. Their tendency to shop little and often could stem partly from the resilience of habit, just as Gwen and Iris continue to eat fish each Friday and a roast joint every Sunday as they have done all their lives. Each has a refrigerator so the issue is not one of preservation, or only insofar as they live alone and cook for one so are cautious not to overbuy and risk wasting food. The primary reason is simply that they all shop on foot. Dorothy reflected for a moment while we spoke, realising that for the fifty years she had lived there, virtually every item of food that had come into the house she had carried there herself. Elsie finds she has to shop several times a week, “because I can’t lug everything back myself.” How much they buy at any one time is limited to what they can physically carry, an amount that has diminished as they have aged, so in their case the absence of a car has shaped their shopping patterns more than the presence of a fridge.

I was struck by how many interviewees sounded hesitant, even apologetic, when they ‘admitted’ that they did most or all their grocery shopping in supermarkets. Like Frances, they appreciate the convenience that supermarkets offer even if, on an underlying level, they do not entirely approve of them. Fully cognizant of the contradictions in their own behaviour, they mourn the loss of a ‘traditional’ landscape of small shops, even as they make the choice to discontinue the social practices that sustained it. Grace commented:

> I’m afraid I do go just to Tesco’s. You know, it’s just more convenient than going from place to place, although you regret the demise of all the lovely old personal shops.

Of course, the refrigerator did not ‘cause’ these changes directly. It does not determine the ways in which and places in which people buy groceries, or the manner in which those groceries make their way home. It is, however, part of a suite of technologies, infrastructures and practices that have together reconfigured the retail landscape, the shape of domestic routines and the journeys of people and things.

SHELF LIFE

In discussions about food storage, date stamps on packaged foods became a common topic and one that raised a range of issues about consumer knowledges and refrigeration practices. The European Food Labelling Directive (2000/13/EEC), implemented in Britain under the Food Labelling Regulations 1996 (SI 1996/1499), requires that prepacked foods indicate their shelf life on the label. Two main kinds of date tagging are used: ‘best before’ dates and ‘use by’ dates. The two have important differences, with the former relating to food quality and the latter to food safety. While the Directive makes these dates compulsory for most prepacked foods, optional ‘sell by’ or ‘display until’ dates may also appear on packages. Designed to aid stock control in stores, these are intended as a guide for retail staff rather than for customers. In keeping with findings in food policy and health and safety literatures (for instance, FISS 2007b), my conversations with interviewees revealed widespread misunderstanding of the terminology and the distinctions between different kinds of dates.

Date stamps and generational differences

As the name suggests, a ‘best before’ date represents the period during which a product can be expected to remain at its best. Once a product’s ‘best before’ date has passed, its flavour, texture, appearance and nutritional value will start to deteriorate, but it does not mean the food will necessarily become unsafe to eat. If stored and handled properly, most foods will last well beyond this date, albeit not in peak condition.[57] It is common for prices to be marked down in retail stores as foods approach this date, but the Food Standards Agency (FSA 2007) points out that because ‘best before’ dates are a measure of quality, and were never intended to be an indicator of safety, it is not an offense to sell food beyond its ‘best before’ date, so long as it remains in good condition and does not pose a risk to health.[58] Most shelf-stable packaged

57 The exception to this rule is eggs, which fall under different labelling regulations. The date marking of eggs is controlled by the European Commission’s Egg Marketing Standards Regulations. Eggs are given a ‘best before’ date but the FSA stresses that they should not be consumed after this date because of the risk of salmonella bacteria multiplying to dangerous levels.

58 There are no restrictions about selling products after their ‘display until’ or ‘sell by’ dates, though it is illegal to alter the dates manufacturers put on the packages. Cases of tampering have been uncovered and prosecuted.

goods, such as canned, dried and frozen foods, are given a ‘best before’ date, but there are certain items with much shorter product lives for which manufacturers are required to provide a ‘use by’ date instead. These are foods that, “from the microbiological point of view, are highly perishable and are therefore likely after a short period to constitute an immediate danger to human health,” especially those that will not be cooked before consumption, or are unlikely to be reheated to sufficient temperatures to destroy pathogenic micro-organisms (FSA 2003). Products like bread and baked goods deteriorate rapidly, but because they become unpalatable rather than unsafe they carry ‘best before’ dates instead of ‘use by’ dates. Items given ‘use by’ dates are generally the moist, protein-rich foods in which bacteria thrive. Examples include poultry, meat products, smoked fish, soft cheeses, ready-prepared salads such as coleslaw made with mayonnaise, sandwiches and dairy desserts. Because they go off quickly, these are generally the kind of foods kept refrigerated to minimise the risk of food poisoning.

The ‘use by’ date indicates the final date up to which the food should be consumed and beyond which it may not be safe and, unlike ‘best before’ dates, it is illegal to sell foods after their ‘use by’ date has expired because of potential health risks.[59] The shelf life of chilled food is usually considered to be ten days but dates also depend on the material state in which products are retailed, for example, things that require a ‘use by’ date when sold fresh, do not need one if sold frozen (CCFRA 2004). Responsibility for determining the durability of food products lies with the manufacturer (ISFT 1993). However, an important caveat is that dates are only valid if foods are stored and handled appropriately by consumers. The onus is therefore on the consumer to follow the manufacturer’s directions printed on the label, for instance, to ‘store in a cool dry place,’ ‘keep refrigerated once opened’ or ‘once opened, consume within one week.’ If the instructions are not followed, foods are liable to spoil more quickly; chilled and frozen food may go off before the designated date if it is permitted to get warm and, irrespective of the date that happens to be stamped on the bottle or the carton, milk will turn if left at room temperature rather than refrigerated.

59 ‘Use by’ does not necessarily mean ‘consume by.’ In cases where a food can be frozen, freezing will extend its life meaning it can safely be consumed beyond the ‘use by’ date.

Many people assume, wrongly, that ‘best before’ dates refer to safety rather than quality. This misunderstanding leads people to treat them as expiry dates and to dispose of food unnecessarily, as exemplified by Efia’s confusion with corned beef. Efia remembered buying corned beef long before the tins started having dates stamped on them. At that time, she never worried about storing them for lengthy periods,

> but now you buy them and even though they are supposed to be preserved in the tin, you get six months or so and then you look and they have expired so you just throw it away.

Unlike fresh meat, which goes off fairly quickly even when refrigerated, tinned meat has a long shelf life. A tin of corned beef will be given a ‘best before’ date to indicate when its quality is likely to deteriorate, but Efia interprets this as an expiry date, an instruction that she should immediately discard the item once date has passed. She is not alone. Abigail, a doctor, demonstrates a similar misunderstanding. Before she had her kitchen redesigned, she despaired of ‘losing’ tins and packages at the back of the kitchen cupboards:

> We had lots and lots of food, dried food, and there was a tendency for stuff to sit there for months and months and months and months and by the time you discover it, uh oh! it’s out of date and goes in the bin anyway.

Minutes of the Food Industry Sustainability Strategy Champions' Group on Waste state that “80% of consumers are reported to be confused by date labelling and many treat best before dates as use by dates” (FISS 2007a, p. 3). We also see the converse whereby people regard ‘use by’ dates as a rough guide to which they need pay little heed. The situation is complicated by the fact so many people tend to talk in terms of ‘sell by’ dates (even though, strictly, these are dates for retails not consumers). Confusingly, this has been widely adopted as the common shorthand used interchangeably with, or in place of, ‘use by’ and ‘best before’ dates, which makes it difficult to determine which kind of dates people are referring to in interviews, in the media, in non-specialist literatures and even in government circles.

Dates rarely become an issue for Maggie and Simon. They plan their meals in advance each week, buy the food they need and generally use it up quite efficiently so that it is not left in the fridge or cupboard for long. They tell me they are not too concerned about things being a few days beyond their date, confident that an extra safety margin is always factored in. Although they claim not to worry about dates, it is clear that they make a distinction between different kinds of foods and the relative levels of risk they carry. They are more careful when it comes to meat, particularly chicken, as they know that salmonella could be a concern. For other kinds of food Maggie comments:

> I'm not really that worried about it, to be honest. If it looks blooming awful I'll throw something out, but we don't normally have food that's that late. My daughter is very prissy about these things. She goes round and chucks things out.

Maggie's choice of 'prissy' to describe her daughter's behaviour tells us she is more particular about these things than her mother. Its slightly pejorative tone also hints that Maggie finds her daughter overly rigid in her date disposal habits. Ronnie Porter told me that he uses things beyond their dates "within reason," before referring to his adult daughter's approach:

> She'd say 'Dad, that's out of date,' and take it out, more or less on the day. But they reckon you can go on using them for two or three months after. I can't really see any harm in it.

Where he sees no harm, his daughter sees a rule to which she should adhere. A consistent pattern emerged from almost all my interviewees with older children. Children were much more strict than their parents when it came to dates. Efia considers herself fairly careful about dates but her daughters, even at the ages of 9 and 13, are stricter still. If they notice something beyond the date they insist it be thrown away, "even if it's just two days. They don't understand if it's just a day maybe it's still good."

In a 1992 Gallup Poll, participants were asked how often they exceeded the 'use by' date on products in their refrigerator. 63% said never, with women a little more likely to stay within the dates than men, and respondents with children marginally stricter than those without (Gallup 1992, p. 35). 30% exceed the date 'rarely' or 'sometimes,' and 6% professed to do so 'often.' Examining this 6% more closely reveals quite a variation by age; 9% of respondents aged 35 or older 'often' overlook the date, three times as many as the 18-34 age group, where the figure dropped to just 3%. In Gallup's study, gender differences were not particularly pronounced, compared to differences by age, but among my interviewees, it was always daughters who were reported to adhere to dates more strictly than their parents. No one mentioned their sons doing this.

Reconfiguring relationships with food: trusting 'science' or 'common sense'?

When I asked him about keeping track of food, Tony Hawks confessed:

> I'm not very good at that. I pretty much go for a) smell it, b) is there anything growing out of it? If there's nothing growing out of it, I'll eat it. 'Best before' doesn't mean you can't eat it, it's just not at its best. I mean, someone who's working every day with food, they know. 'Best before' is for the people who are too busy to know what's happening in their lives, you know, charging out and coming back, having a look at this, throwing that away.

His humorous and self-deprecating comment nevertheless revealed that Tony had a good grasp of what 'best before' dates really mean, along with a perceptive insight into different ways of 'knowing' and engaging with one's food. Two contrasting approaches to 'reading' food and freshness emerged from my interviews, each predicated upon different knowledges and practices. One stems from a direct sensory engagement with foods themselves, the other from a more literal reading of food packaging and date stamps. Thus, for Maggie, looking "blooming awful" is an indication that something has gone off. Where she takes the appearance of food as her primary cue for whether or not it is fresh, her daughter is guided by the label.

Years of handling food can give people an intimate insight into its condition. Iris was one of many who drew on powerful tropes of sensory engagement as a way of understanding food. She was adamant: "if butter or bacon went rancid in hot weather, you'd only have to taste it. … you'd *know*." Her view was that recognising when food is fresh and judging when it is best avoided should be self evident to anyone who used their sense of smell or taste. Dorothy shared the view that it was simply a matter of common sense:

> Dorothy: I keep things in the fridge past their dates and I've never had any problems, I mean, if it's bad you don't eat it do you!
> Me: Would you trust being able to tell if it's bad just by looking?
> Dorothy: You smell it. … I mean, it's only a few years since you've had dates on tins anyway and I can't remember anything ever going wrong. If a tin's blown or anything's bad, well you chuck it.

For Iris and Dorothy, smelling and tasting are primary strategies and, as for Maggie, visual signs also give important clues. These include unusual colouration, obvious signs of mould or infestation or a ‘blown’ and bulging tin, which indicates abnormal pressure building up inside due to bacterial reactions. Martin Higgs, one of the participants in a BBC News online discussion forum titled “Do you waste food?” describes the hierarchy of sensory tools he relies upon, confident that dates “always tend to err on the side of caution. If the food is past the use-by date but looks alright, I try smelling and then tasting it before making a decision on whether or not it's edible” (BBC 2005). The majority of posters on the site did not agree with throwing something away just because the date has passed, though almost as many noted a need to be more wary in the case of meat or poultry. “I don't take much notice of sell by dates, I trust my nose more!” wrote Su from Southampton. Some expressed bemusement or incredulity at others’ blind adherence to these dates, just as Dorothy had done when we spoke: “things don’t start going bad at twelve-o-clock on the day, do they!” she exclaimed.

People posting to the online discussion were quick to point out how recently in the historical record such technologies were introduced. In Nigel Fletcher’s words, our ancestors “existed for thousands of years without sell-by dates. People used their eyes and noses to tell whether food was edible.” Brigitte advocates to the “look and sniff test,” arguing that “if food has been handled and stored properly, even when it is past its sell-by date, there should be no reason to throw it out unnecessarily. After all, most of our predecessors survived, even without fridges.” Many put forward their own experiences as ‘evidence’ of the reliability of their methods. “I use my eyes, nose and taste buds to tell me if food is OK to eat, and ignore any dates on the packaging,” says Amy, adding that “people should be less fussy. … A bit of mould – scrape it off! By the way I am rarely ill!” Frances Soar (MMB) commented that for most of her life “they hadn't invented sell by and eat by dates, so you just carried on eating it until it had gone. You didn't worry.”

Janet Cooper thinks people worry about dates too much. She told me that in her generation everyone would have eaten food so long as there was not mould on it and it did not smell bad. In her opinion, “all you need is your nose and your eyes,” though she did not think her daughters would agree. Here, once more, profound generational differences exist, even amongst members of the same family. Older interviewees were much more inclined to ‘read’ the food instead of the packaging and to trust their senses, having relied upon them all their lives before foods were dated or even widely refrigerated. Those giving more weight to the written word, and privileging the dates and directions printed on the packet, are predominantly younger people and those living 'harried' lives (Southerton 2003), the ones Tony characterised as charging in and charging out and throwing things away. There is an important difference in where each approach locates knowledge. Those ascribing authority to traditional 'common-sense' methods point to the accretion of skills and understanding embodied in the individual. Those more comfortable deferring to external sources of expertise, rather than relying upon their own senses, delegate responsibility for signposting when food is good to distant unknown others judged to carry scientific authority.

A clash between competing knowledge systems can provoke strong feelings, as in Pat Thornton's online response to Elliot and Leroux's article in the *Times*:

> So I am not alone in thinking that the proliferation of use/sell-by dates is an insult to my intelligence? … As for food, I'm lucky to be old enough to know how to use the senses I was born with, rather than rely on experts to tell me that something is edible or not (Elliot & Leroux 2007).

Pat is indignant that the validity of the skills and knowledge she has built up through her life are being delegitimised. She feels perfectly capable of using her own expertise to evaluate food for herself, refuses to defer to the figure of the 'expert' and finds such attempts to dictate 'correct' practice in domestic matters patronising. That she refers to being "old enough" to have developed this competence reinforces, once again, the generational dimensions to differences in approach. Back on the BBC discussion forum, Margaret advocates "teaching people to trust their senses with food, not the packet it came in." Rebecca Robinson agrees, arguing that "we need to learn to look at food, touch it, smell it and not just read it," that is, to assess the food itself rather than the label (BBC 2005). However, it could be argued that this is not learning so much as *re*-learning skills that have progressively been lost. In an interview for *The Guardian*, food writer Joanna Blythman commented that "it's gardeners and people from an older generation who understand what freshness really is" (Weale 2002). These are precisely the kind of people Tony alluded to earlier as "really knowing" food by virtue of having worked with it over long periods, people like Ronnie and Brenda who grew all their own vegetables, or Iris, Gwen and Dorothy, who took sole responsibility for shopping, cooking and feeding. Younger generations brought up on supermarket fare, or more familiar with 'assembling' food than making it from scratch, may have had neither the opportunity nor the incentive to train their senses in the same way. They are likely to have developed different sets of knowledges and skills and to have a different degree of intimacy with fresh foods, one more reliant upon codified than tacit knowledges.

De Certeau *et al* draw attention to the new knowledges and new gestures that contemporary grocery shopping requires or assumes. They observe that:

> To do one's shopping, one really has *to love reading* and know how to decipher labels. … [O]ne has to find the date and grasp the meaning. … Buying food has become a skilled work that requires several years of schooling. … It is thus necessary to read, examine, and compare … One must especially know how to combine all these fragments of knowledge and be able to mobilize them in an instant, almost effortlessly. Thus, the gestures and the practices of the buying woman have had to be transformed in order to adapt to new market habits. In the past, one had to learn how to look at things … to estimate the quality of a cut of meat in the wink of an eye, to smell the almost too-strong odor of cheese, and to notice the yellow color of butter past its prime. Today, one must know how to read and trust no longer in a personal and empirical savoir faire that comes from a traditional structure, acquired through long apprenticeship, within the familiarity of an elder, but in a collective scientific knowledge, codified in regulatory statements and transmitted anonymously. You have to believe in the wisdom of state-controlled regulations whose how and why escapes you. … Each person must *support through belief* the entire edifice, must *believe* the norms to be in accordance with one's own interest and the indication placed on packaging to be truthful (de Certeau 1994, pp. 208-9).

But is it still possible to trust one's nose? Blythman suggests that many of the technologies adopted in the food industry hinder traditional methods of judging foods. Increased packaging, for example, prevents consumers from using the smell or texture of food to judge its quality or freshness. Tightly sealing foods in layers of plastic, paper, cardboard or polystyrene creates a material barrier to protect it, but, in so doing, enacts a spatial separation which subtly distances consumers from their foods. Notions of 'freshness' also get disrupted by a battery of preservation techniques used to extend food's shelf life. Some shifts were made explicit, for instance in the marketing campaigns that promoted the concept of 'frozen freshness' as a way of selling freezers. Others were more discreet. The industrialisation of food production sees fruit and vegetables stored in refrigerated spaces, packed in 'modified atmospheres' and 'gas flushed' to artificially ripen them, none of which is necessarily evident to the consumer selecting produce in the store. As food production changes, old rules for 'reading' food do not necessarily translate. As a result, consumers are "constantly wrong-footed [because] all your senses that would normally give you an indication about the life of food cannot be relied upon," something Blythman regards as "all part of de-skilling us as shoppers" (Weale 2002).

That said, there is a danger of lapsing into a simplistic and romanticised view of 'traditional' or 'common-sense' relationships with food. Relying on sensory readings may be more problematic than it looks. In light of changes in the methods of production and in the journeys that foods take, this approach might be insufficient to safeguard consumers from foodborne disease. Although steps like wrapping and refrigeration are intended to improve food safety, contamination can potentially occur at any stage of the process, from growing to harvesting, transporting, processing, retailing, storing or preparation. A contributor who identifies themselves as LBW from Reading suggests that "nearly all food is obviously either ok to eat or 'going off'" (BBC 2005). Unfortunately, there is another possibility. In many of the exchanges about food safety, attention centres on whether food is 'off' or not. Arguably, this focuses on the wrong question. More pressing is the issue of whether it carries the microorganisms responsible for food poisoning, which is not the same as being 'off.' The trouble with bacteria like *campylobacter* is that they are impossible to see or smell or taste, as Abigail, recounting her experience of a nasty case of food poisoning, discovered to her cost. In its newsletter for childminders, the Northamptonshire Food Liaison Group endeavours to make the distinction; "remember, food poisoning does not make the food go off," it warns, "if it did no one would ever get ill!" (2003, p. 2).

Moral economies of safety versus waste

Dorothy had recently watched someone checking the dates of food in their fridge prior to going shopping. "She threw masses of stuff away," Dorothy exclaimed, "it was ridiculous!" With evident exasperation, Iris described a similar pattern with her daughter:

> I go to my daughter's house and she'll go through the fridge and say 'oh that's gone off, it's passed the sell by date,' 'oh no, can't use that.' You never had that in the past as you bought only what you needed. You just wouldn't throw things away.

Younger interviewees' relationships with food frequently stood in sharp distinction to older people's, many of whom grew up in a social context where they learned to eat what they were given because wasting food was something few could afford to do. Leftovers were remade into new meals and, for those with gardens, scraps and peelings went on the compost or were fed to pigs and chickens. In most households, 'wasting' food would have been a highly unusual domestic practice.

Now, it seems, people regularly throw food away, and *lots* of it. *The Soggy Lettuce Report*, published in 2004 by international financial services company Prudential, examined the areas in which British adults wasted most money (Prudential 2004).[60] Food topped the list.[61] Lettuce, as the title of the report suggests, proved to be the item most frequently thrown out, followed by bread, fruit, milk, cooked meat, packet foods, spreads and dips, cheese, prepared meals and fresh meat and fish (Prudential 2004, p. 5). Moreover, the report noted that much of this food was untouched and still in its packaging. The following year, an award winning BBC Radio 4 programme, *Costing the Earth: The Best Meal You'll Never Have*, investigated the amount of food discarded on its journey from farm to fridge (Heap 2005).[62] Presenter Tom Heap revealed that, according to figures from DEFRA and the National Farmers' Union, some £20 billion worth of food is thrown away each year, three million tonnes by manufacturers and retailers, and more than double that amount by consumers.

Lord Haskins, a government advisor on food and rural affairs, spoke out in the national media to draw attention to what he described as outrageous levels of waste and to call for government action. Much of the problem, as he saw it, was the British public being "too neurotic" about dates (Elliot & Leroux 2007). "Food is thrown away because we are obsessed with sell-by dates," according to the Waste and Resources Action Programme (WRAP, http://www.wrap.org.uk). "Just think of the energy that goes into producing [and] distributing this food." WRAP calculates that the energy invested throughout the food chain in producing, processing, packaging, transporting and storing food is responsible for around one fifth of UK carbon emissions. When that food is thrown away its 'embedded energy' is squandered. In their millions, people take the trouble to buy foods in which considerable labour and resources have already been invested, take them home and store them, but do not get around to eating

60 In April 2004, 1010 adults across Britain were surveyed. The amount of money wasted on unused goods and services was calculated at £80.6 billion per year (Prudential 2004, p. 2).

61 Other categories examined included gadgets, hobbies, entertainment, travel and luxury items.

62 The programme won the award for Best Radio News or Current Affairs Programme at the 2006 British Environment and Media Awards (http://www.wwf.org.uk/bemas/winners2006.asp).

them before they go off or pass their date stamp. WRAP's research claims that up to 30% of the food items purchased in supermarkets end up going straight in the bin (http://www.wrap.org.uk/retail/index.html). Strictly, many of those foods are first dutifully unpacked into the fridge, kept chilled day and night and only *then* thrown in the bin. Bizarrely, then, refrigerators act as holding spaces for considerable quantities of food *not* destined to be consumed.

The Food Industry Sustainability Strategy (FISS) Champions' Group on Waste (CGW) suggests that poor home economics skills among young people contribute to excessive levels of food waste generated in the home (FISS 2007a, p. 3). WRAP puts this growing waste down to a combination of poor purchasing habits, poor organisation, poor knowledge and poor practice. The four key factors argued to lie at the root of waste are people buying too much food, not eating foods with a short shelf-life rapidly enough, misunderstanding the differences between 'use by' and 'best before' dates and failing to store food correctly. Lisa, one of the youngest of my interviewees, was the only one who spoke of a need to organise things on the fridge so that the oldest food was kept at the front and eaten first:

> Lisa: because you know you have to rotate food in the fridge. …
> me: You say rotate, meaning?
> Lisa: Things like yogurts, things that go out of date after a few days.

Much more common were reports of 'losing' things at the back of an overfilled fridge, only to rediscover them too late, like Grace:

> I do quite often buy the bags of salad, vacuum packed, which are very fat and then there isn't room in there [*pointing to the salad drawer*] for them so they tend to move up and then everything gets completely chaotic. And one of those bags works its way to the back and I find it a fortnight later horribly drippy and sweaty.

Food represents 19% of domestic waste, much of which consists of overripe fruit, shrivelled vegetables and all that soggy lettuce. Another major component is cooked leftovers. Haskins suggested that part of the problem with wasted food was a lack of knowledge or imagination about what to do with leftovers. "Teaching people to trust their senses with food, not the packet it came in" and "educating people on how to cook using leftovers," would help reduce waste, suggests Margaret on the BBC webpage. It is notable that cookbooks in the first half of the century typically included advice and recipes for leftovers, just as early refrigerator handbooks had specific instructions for how and where to store leftover food (as in the storage 'maps' illustrated in the previous chapter), as well as meal suggestions for how to use them. Indeed, part of the basis upon which the first refrigerators were promoted in marketing campaigns was their ability to minimise the waste of leftover food.

Maggie and Simon either keep leftovers in the fridge overnight and use them up the following day, or they freeze them straight away. Lisa, on the other hand, despite her scientific background, is not keen on the idea of freezing leftover food:

> I just don't like the idea of eating something again, like in three months time from when I cooked it. I like doing things fresh. It's totally irrational and not scientific, but the thought of digging some food out that I'd eaten, I just find it a bit, it wouldn't be very appetising to me.

Efia Boateng confessed to throwing out quite a lot of food. She, like Lisa, seemed uncomfortable with the idea of freezing cooked food, so if family members did not use up leftovers in the fridges within a couple of days, they would be thrown away. She conceded there was likely to be nothing wrong with that food, but explained that her family "have this psychology," a kind of vague discomfort about the idea of eating food more than a day or two old, even if it has been stored in the fridge. For them, revisiting the same meal again is unappealing. The reactions of Efia's family position them firmly within a culture of plenty, one in which leftovers have become rather unfashionable. Leftover food tends not to be afforded value and it is quick to be categorised as 'waste' rather than as something in which time, energy and skill have already been invested. The Boatengs are used to having a full fridge and like many, though not all, contemporary Britons, they share the privilege of being able to throw food away. They do not *need* to use every bit of food with care in the way that people still remember having had to during postwar rationing. In their home, throwing away excess food – and food which Efia herself acknowledges is probably still fine to eat – is now a normal part of consumption. It was a remarkably common finding that surplus food was stored in the fridge for a number of days even though interviewees admitted that they invariably ended up throwing it away. They would not dispose of it immediately, on the grounds that that would feel too wasteful, but what seems to happen is during its sojourn in the fridge awaiting reuse is that leftovers subtly shift status from 'fresh' to 'old' or 'used', whereupon they can be discarded in clear conscience. The refrigerator becomes a site of deferred decision-making, a kind of pending file for holding leftovers while deciding what to do with them. Curiously then, refrigerators could be implicated in *increasing* food waste just as much as in reducing it.

In debates about food waste, we can see people positioned in two principle ways. Two opposing moral economies are at play, each framed around a different notion of responsibility. While some privilege thrift and categorise this kind of disposal as wasteful and irresponsible, others are motivated more by food safety scares. They privilege safety, arguing that erring on the side of caution is the more responsible approach and wasted food an unfortunate but necessary price (see also Lucas (2002) on tensions between hygiene and thrift in relation to disposal). And who does this throwing away? Who performs this act of 'wasting'? In the households I visited it was not exclusively women who took responsibility for feeding, storing and sorting, for monitoring dates and freshness, for cleaning out the fridge, and for ensuring good nutrition, but it was predominantly so.

Grace complained that, more and more, her fridge overflows with half-used jars and bottles:

> Grace: They seem to take up far too much room and every now and then I have to have a purge and turn out the ones that are out of date. … I'm not a hugely efficient fridge person, but I'm working on it. … My daughter eats a lot of jam without sugar in and that, that has to be kept in the fridge doesn't it. And then you, you just *worry* about things once you've taken the lid off them, that they will go off.
>
> Me: So when you say you worry, what do you worry about?
>
> Grace: Well, I mean just worrying about eating things that are out of date. You know, I'm a bit vague and so something that could happen if I don't make an effort.

Grace feels responsible for all those opened jars. She feels that she must remain vigilant. Professing not to be a naturally efficient or organised person, the risk of food poisoning clearly weighs upon her mind, food poisoning that would be her fault for failing to 'make an effort' managing the fridge. She sees her job, particularly as a mother, to safeguard her family's health and safety. Overwhelmingly, women bare the burden of this responsibility and assume the work of worrying as part of the unspoken rules underlying the ideological construction of femininity and motherhood.

NEGOTIATING THE REFRIGERATOR AS A SHARED SOCIAL SPACE

Fridge etiquette

> Imagine that I come to your home for a first-time visit. We've never met before. You have invited me into your kitchen, and we are sitting together at the table in the initial stages of getting acquainted. Now, suppose I get up, open your refrigerator, pull out the makings for a sandwich, and start putting them together. … Even if you said nothing, you would be surprised and probably affronted. Strangers do *not* open your refrigerator without asking (Miller 2002, p. xi)

As a gesture of hospitality, we may invite guests to help themselves to food or drink from the refrigerator but the unspoken rule is that, like any 'private' space, one does not enter uninvited. Miller contrasts this scene with one in which a visiting relative helps themselves to something from the fridge. His argument is that this scenario is different, that this would not be inappropriate or upsetting because "strangers don't have refrigerator rights, but family members do." In *Home Rules* (1994), Wood and Beck detail the fascinating multiplicity of 'rules' that the Wood children have learned about appropriate behaviour in specific spaces and with particular things in their home. Curious about the internalisation of these kinds of codes of behaviour, I consider some of the ways in which certain fridge-related practices are felt to be appropriate, and why. Miller uses the notion of 'refrigerator rights' as a measure of the social closeness and quality of relationships in contemporary American life, but I am more interested here how these rules, rights and also responsibilities play out when access to refrigerator space is not available exclusively to family members, but is also shared with others. Given the correlation between close social bonds and sense of comfort that Miller mentions, it strikes me that people sharing the confined space of a fridge, particularly those who are not related, are forced into a curious kind of intimacy. The refrigerator can therefore become a 'hotspot' where different understandings of the 'rules' and different underlying social values rub up against one another, producing friction.

I focus here on Lisa's experiences to illustrate some of the tensions inherent in fridge sharing. Lisa owns a flat in north London and occasionally has short-term lodgers. I asked about the kind of issues that came up when she shared her flat and her fridge:

Lisa So what are my 'funny fridge foibles,' you mean? Well, the only thing that would really get me would be safety things, like putting meat on the bottom and cooked foods on the top. …

me So is that an issue about having things in the right place?

Lisa It's the food safety aspects of not putting meat dripping with blood on the top shelf when I've got my fruit on the bottom, that would really get to me. I would have to say something about that, overcome the British reserve and say, "look I think we need to sort the fridge, you know, the 'fridge etiquette' out!" … For me, it's just so obvious it gets me angry that people, it's like, 'for God's sake, you just don't *do* that!' But all the people I've shared with have been fairly good at keeping their little area sorted.

To Lisa, appropriate fridge organisation seems obvious, but not everyone has the same grasp of the unwritten rules of what it is you do and "just don't do." Her main difficulties were with a former flatmate who was Dutch and she wonders whether their approaches reflected different cultural norms. In general, she finds things works best if each person has designated space in the fridge:

> I don't mind sharing … but I prefer to have my own shelf because … I find that when you're sharing it you don't tend to notice what's going on because you're never quite sure what's yours, or you forget what's yours. Things tend to get messy.

This 'messiness' can be physical but also cognitive. When Tony lived alone his fridge was big enough, but now he has two lodgers they often struggle to squeeze everything in. At first, they divided up the fridge and allocated space to each person, but he tells me that the 'this-is-your-shelf' situation has grown increasingly blurred. "At the moment I'm tucking into a yogurt that I'm not confident is mine. These are the sort of worries I have, you know, I'm not convinced that yogurt is mine, but I'm having it anyway!" Under their initial mode of organisation, the three were able to decipher ownership from the location of each item, a strategy which helped reduce the burden of remembering with which both Tony and Lisa have struggled.

For Lisa, spatial organisation provides a way to keep track of food and freshness through her system of rotation. Likewise, 'placing' functions as a way of indicating ownership, and therefore responsibility; whose food is whose is clearly signalled by where it is put. However, Lisa's pattern of mobility, the fact that she frequently travels overseas for work, disrupts the regular household 'rules' and in the past this has generated tension around food management:

> If I go away I'd assume that my flatmate would eat any food before it went out of date, but she wouldn't. I was thinking, 'why don't you just eat it?' and she'd say, 'well, it's yours,' but it would be out of date by two weeks by the time I got back! I sort of expect people to be a bit sensible, you know, if they see that something's been there for ages just chuck it as I'm not going to have it when I get back. I suppose I should really be there clearing it out before I go. … She didn't want to use my food, so it's all the politeness, being over-polite and food gets wasted, which is really silly.

Subtle but powerful moral codes underlie the rather uncomfortable dance between these two perspectives on sharing a fridge, perspectives which came into conflict when Lisa was away. Although neither would consider it appropriate for her flatmate to access, eat or throw out Lisa's food when she was home, when she is away the usual rules get waived. Lisa's overriding rule could be interpreted as: Do Not Waste Food. According to this logic, using up someone else's food is "sensible." Frustration arose because her flatmate's fundamental rule was not the same. Instead, it was along the lines of: Respect Other People's Property. This meant that, however helpful Lisa might have found it, 'invading' someone else's space and helping herself to their food did not seem right. Motivated principally by a desire to minimise waste, Lisa's invitation to use her food was also intended as a gesture of generosity. Lisa therefore struggled to understand why, from her flatmate's perspective, eating it would feel like 'theft.' Equally, she may not have recognised the burden of responsibility she placed on her flatmate with the expectation that, in her absence, someone else would and should perform the work of monitoring her food. Their subtly misaligned priorities therefore clashed, generating household tension, as well as waste.

Although Lisa never had the classic case of disappearing food when she lived in a student house, she did experience problems when sharing a fridge in a former job. "I had a yogurt stealer at the Medical Research Council!" she laughed, describing her disbelief at having to post notices telling people not to take her yogurt. As a space accessible to 'unknown others' but working on a system of trust, appropriate fridge use is difficult to police. A more common scenario among interviewees was when colleagues failed to take responsibility for the contents and the cleanliness of shared refrigerators at work. Forgotten or abandoned food and milk go off, spills are not cleaned up and a supposedly 'safe space' for food becomes unclean and unhygienic. Cleaning the fridge is a task few relish, judging by how infrequently people tend to do it, and even less appealing is the prospect of cleaning up other people's mess. As a common space shared between many, each individual's responsibility for the workplace fridge is 'diluted.' To everyone's relief, at Lisa's workplace there was one person, evidently with a much lower tolerance for mess than everybody else, who regularly took it upon himself to clean the fridge whenever it degenerated into a particularly unpleasant state. He would circulate a notice warning people to retrieve their food by a certain date as anything remaining would be emptied out and thrown away. When Lisa worked as a laboratory scientist, she and her colleagues had to take care to differentiate between fridges used for different purposes:

> We always had huge notices on all the fridges in the lab. When we had our own little personal fridge for milk and food and things, we always had a big notice on it saying 'do not store samples here', things like that, which always made me wonder what people used to store in there before the sign went up!

In each of these instances, normally unwritten rules of social behaviour and fridge use had to be written down to remind or educate those who failed to understand or chose to ignore them. Although few people are faced with finding laboratory samples in amongst their yogurts, there are plenty of instances when unusual items crop up in the fridge.

Ordering practices: fridge contents 'in' and 'out' of place

A 1992 Gallup survey asked participants whether anything their partner kept in the fridge particularly annoyed them (p. 60). Some responses focused on foods that respondents found unappetising, like dripping, hummous, 'keep fit' food or shark meat; things they considered unhygienic, like pet food; or things they thought took up too much room, like cans of beer. Another category of answers were less about specific foods than about things being stored incorrectly, such as food left uncovered, vegetables in 'sweaty' plastic bags, empty milk bottles and food that had gone out of date. Other answers included foods that respondents believed to be out of place in a fridge at all.

Where to keep the ketchup was a source of sometimes fierce debate in the households that I visited, as the refrigerator faction battled it out with the cupboard contingent. What is the 'proper' place for ketchup and who gets to decide? My interviews uncovered opposing schools of thought about the 'proper' place to keep things like bread, jam, ketchup, Marmite, mustard, potatoes, eggs and fruit, and whether they belong in a fridge or not. The 'rules' are sometimes contradictory. "Never keep bananas in the refrigerator," a BTH handbook spells out in bold

(BTH 1943, p. 10), and yet when I was interviewing Abigail she noticed with surprise a picture of bananas in a fridge in the brochure she was showing me, “now bananas are something I wouldn’t *ever* put in a fridge,” she exclaimed. When I went to Ruth’s home, her mother Mona was visiting from Canada. The two talked about some of the cultural differences in fridge use in each country. At one point Ruth had thought of getting a large American-style fridge, until she examined them more closely in the showroom:

> When I saw the size of them I thought what in the world would I put in it? But there’s all kinds of things we just don’t put in fridges here you see, which they do in Canada. … There’s such a lot one keeps in the fridge that really doesn’t need to be here. So you can get away with quite a small fridge.

Living in Britain with her more modest fridge, but also with the benefit of her highly-prized built-in ventilated dresser (as pictured above in Figure 5.2), Ruth is more selective about what goes in the fridge than her mother in Canada, for whom it is very much a default space where “everything” is put. Ruth keeps some vegetables in the fridge, but root vegetables all go in the larder. In her mother’s case, all the vegetables go in the fridge, including potatoes, which Ruth would not dream of refrigerating. “Jam and ketchup, all that stuff I keep in the fridge,” said Mona, whereas the proper place for these in Ruth’s house is in the cupboard. Mona does, however, draw the line at fresh fruit. She commented that “North Americans put everything in the fridge, but I feel that when your ice-cold fruit comes out of the fridge you lose that sweet flavour.” Ruth raised a similar point about low temperatures inhibiting the flavour of cheese. The Hägens do store their cheese in the fridge but their practice is to take it out a few hours before eating it in order to improve its flavour. Ruth and her husband had recently parted with his grandmother’s striking bright red 1952 Frigidaire, which they had been using as a second fridge up until donating it to the Science Museum’s Domestic Technology Collection. In recent years the thermostat had been unreliable so, concerned that it never seemed particularly cold, Ruth had stopped keeping meat in it but found it to be ideal for things like bottled drinks, vegetables and cheese, on the basis that these are better kept at temperatures a little above that of a regular refrigerator. In this way, Ruth took advantage of a surprisingly diverse range of storage spaces in her kitchen which offered different temperatures, from the freezer and the fridge, to the slightly warmer second fridge, the ventilated larder and the kitchen cupboards.

Efia told me that in Ghana, due to its hotter climate, salad cream and ketchup always go in the fridge, whereas in her London home, they go in a cupboard instead. Everything has its allocated place in Efia's fridge. "That is one thing with me, it's *always* the same place." The same is true of her kitchen cupboards. The rest of the family know where everything belongs and have been well trained to put things back in place. Similarly, Marten and Scott's research participants "exhibited a 'routine of being' in the kitchen, suggesting they have an intimate tacit knowledge of the kitchen (where things are kept, what the distance is between objects, and what level of muscle power is necessary to open and close doors" (2004, p. 36). I asked whether things had a set location in Maggie and Simon's fridge. "Oh it does with him, yes! I get in trouble if I do any cooking and put it in the wrong place," Maggie muttered. Nevertheless, because Simon is a 'househusband' who does all the cooking and the shopping, she regards the fridge as more as his territory than her own and thinks it only fair that he gets final say over what lives where. Simon was formerly a librarian and Maggie sees an innate sense of ordering underlying his shopping and storage habits. She showed me where things were kept in the fridge: "dairy products are there, cheese is there. … I think it's based loosely on recommended temperatures and we tend to keep groups of food together." One thing that never goes in the fridge is bread. Aware that this is a much debated issue, Maggie has done her homework on the best bread storage practices:

> Bread keeps best frozen or fresh. I've read quite a few things that say you either freeze it or eat it fresh. It goes stale in the fridge. The sources I've read convince me.

It was clear from my conversations with interviewees that some people are more particular than others about where things go and some find it extremely irritating when things are 'out of place.' "I'm that way, aren't I, about the dishwasher," Peter said. "The fridge is Grace's territory. I'm the obsessive one. I don't like it when somebody else has done it. I want to put things in the *right* place." In an informal division of territory and labour, Peter oversees the 'proper' ordering of the dishwasher and leaves the fridge to Grace. Anything but obsessive, she admits to being rather vague and forgetful and liable to mix things up or misplace them:

> My daughter was very surprised because she'd asked me to buy her a bottle of Ecover washing liquid, and I thought she meant washing up liquid, so I did buy her one last week, and she found it in the fridge. … That's fairly typical!

Peter urged her to tell me the story of the iron: “Yes, it is rumoured that I once put the iron in the fridge, but I can’t actually remember that one,” she sighed.

My conversation with the Templetons about food being in the ‘right’ or ‘wrong’ place prompted the following playful but revealing exchange. “I think that bread and Marmite ought to be left out of the fridge,” Peter declared. Disagreeing, Grace said, “oh no, I put them in the fridge.” Peter continued, “I *know*, but I don’t say anything about it. I’m being good! You don’t realise how good I am,” he teased Grace. “It’s so it doesn’t go off,” she protested. “I wrap bread in foil and put it in the fridge.” “And then it’s all cold and nasty when it comes out,” he whined; “it ought to be wrapped in foil *outside* the fridge.” Peter roared with laughter; amused that they should have stumbled straight into precisely the kind of passionate dispute we had been discussing. “You see this great opportunity, things I never brought up, bottled up for twenty years” until now, when a chance interview about refrigerators touched upon deep-seated feelings about the proper place of things, the rights and wrongs of cooling and their effect upon domestic harmony.

The Rowles’s are highly unusual in having a large custom-built corner fridge (Figures 5.3 & 5.4). They had their kitchen redesigned four years ago and were planning on having a corner larder and an American side-by-side fridge until their designer suggested a corner fridge produced by a Norwegian company, Norcool, instead.

Figure 5.3 Abigail's built-in Norcool corner fridge

Figure 5.4 Inside the Norcool refrigerator

Source: own photographs

The Norcool functions as a kind of refrigerated larder, a multipurpose storage space in which they put everything they would keep in a conventional fridge, and some additional things besides. Jam and flour are kept there, as are tins of food and even open boxes of cereal. There are just a handful of things Abigail finds do not store well, such as open packets of biscuits, which go soft, or jars of peanut butter, which go too hard. Abigail comments that now she gives little conscious thought to what should or should not go in the fridge and no longer struggles to fit in all the groceries after a weekly shop for a family of five. “What I don’t miss about having a normal fridge is, you know, you go round Sainsbury’s and you buy everything and get it home and then think, ugh, I can’t get it all in the fridge.” Another advantage is that: “if you’re really in a hurry with shopping on the way home, you don’t even have to unpack it, you can just put all the bags straight in the fridge.” Here, the refrigerator has become a ‘catch all’ space for an increasing range of goods, even more so than Mona’s fridge in Canada. This is a space which demands less thought than a conventional refrigerator; if in doubt, put it in.

A broad array of non-food items can be found in people’s fridges. Steph Jacobs has to take medications for various conditions including rheumatoid arthritis. Some need to be stored below a certain temperature, so in Steph and Donna’s second fridge, located in the garage, the top shelf is a dedicated space for medicines. All manner of things from maggots, camera film and photographic chemicals to teething rings, oil paints, yarn and cosmetics are regular refrigerator inhabitants. In the course of my research, I was reliably informed that after a spell in the fridge, eyeliner pencils are easier to sharpen, mohair wool is easier to knit, wet socks dry rapidly and underwear becomes much more refreshing to wear in the summer. Mike McFadyen returned to his description of the principles upon which a refrigerator works to explain to me why socks should dry so effectively:

> It has to be an auto-defrost fridge. How they work is the backplate goes down to an incredibly low temperature, about –22. All the moisture on the fridge condenses on the back plate and turns into ice. When the thermostat switches off the plate is allowed to warm to about 6 or 7 degrees. All the ice in there melts and runs down a channel in the back to the top of the motor where it evaporates and goes back into the atmosphere. The consequence is that the humidity inside the fridge is virtually zero, so anything that isn’t covered dries out. So cheese that isn’t covered, or lettuce, will just literally dry out. And if you want to try an experiment put a pair of wet socks in the fridge and within a very short amount of time they are dry.

This neatly illustrates the principle that technologies can be deployed for ends other than those for which they were intended. Here, I show the extent to which refrigerator practices have diversified, turning the fridge into something associated with far more than simply food. These practices supplement rather than displace its food-related functions. Their emergence illustrates the way that objects can be simultaneously situated within different regimes of practice. 'Scripts' may encourage users to act in certain ways, but sometimes users stray from the script and begin to improvise.

Rescripting the refrigerator

From the fortuitous accident of design that created a magnetic surface at eye level arose a striking example of 're-scripting' whereby the refrigerator became appropriated in originally unintended but now culturally familiar ways as a bulletin board and display space (Watkins 2006).[63] 'Decorating' the refrigerator in this way has the effect of diminishing its mechanical appearance and helping to affirm that it belongs in domestic space. Many refrigerators in contemporary Britain, though of course by no means all, are decked with magnets, shopping lists, notes of things 'to do,' useful contact numbers, handy household hints and what Pickering (1989) terms 'expressions of self,' such as meaningful mementos, family photographs, spiritual inspiration, 'child pride items' and personal humour. While the logic of a shopping list on the fridge door might make sense, its establishment as a place for poetry is more unexpected. Yet, since 1993, magnetic 'fridge poetry' has grown into an international pop-culture phenomenon with kits available in dozens of languages on themes from Art to Zen, via Erotic, Postmodern and Yiddish.[64]

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63 There is a history and geography to the notion of a refrigerator at 'eye level.' Traditionally, North American refrigerators have been much larger than in Britain. Infrastructural constraints of smaller British kitchens made smaller fridges the norm and, with the rise of fitted kitchens, fridges were commonly designed to fit under a countertop. Following the huge increase in ownership of upright fridge-freezers during the 1980s and 1990s, and growing demand for larger side-by-side 'American style' fridges, an eye-level fridge surface is now common. Of course, what constitutes 'eye level' also varies, particularly by age. The fridge door is often a child-oriented space and for young children even small fridges will be at eye level.

64 Magnet fridge poetry (sets of individual words on magnetic tiles that can be rearranged to make poetry) was copyrighted in 1993 by Dave Kapell. FunkyFridge.com carries over 130 different themed kits.

Among my interviewees, just under two thirds had things posted on the fridge door. In a 1992 Gallup survey, about half the 518 participants did and half did not (Gallup 1992, p. 76-7). Magnets were the most common item (45%), followed by messages and reminders (14%), pictures or drawings (13%), postcards or photographs (6%) and letters or bills (4%). The survey found little variation by class or gender, but quite a striking difference by age. Decorated fridge doors were twice as common among younger people than older; 60% of the 18-34 age group put things on the fridge, but only 30% of people aged 55 and above. There was also a contrast between households with children and those without. Double the number used the fridge door for reminders and messages, and four times as many displayed pictures and drawings on the fridge (Gallup 1992, p. 76-7).

The size of the refrigerator bore a close relationship with people's decorating habits. When the Templetons commented on the evolution of the refrigerator into a display space, Peter reasoned that, "it's probably because it's big as a space, it's tall. If it was one of those little fridges down there it wouldn't have." Grace added, "it's an eye-level empty space and it's white, at least in Britain they're usually white. It's a good background." People with fridge-freezers were far more inclined to stick things on the door with magnets than were those with smaller fridges fitting underneath a counter-top, presumably precisely because the taller appliances offer the eye-level surface that smaller fridges lack. In the Gallup study, around half as many again had magnets, postcards or photos on fridge freezers compared to small fridges, double the number had messages or reminders, three times the number had letters and bills and nearly five times as many had pictures and drawings. Fridge size and household composition are often closely linked. Those in the younger age group are more likely to have small children, just as those with larger families are more likely to have bigger fridges. A tall fridge or fridge-freezer and the presence of children in a household increase the likelihood of the fridge door being decorated, whereas a significant proportion of older people live alone,[65] have smaller fridges, and are less habituated to the fashion for fridge decoration.

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65 Figures from the 2001 census show that 30% of British households are single-person households and nearly half of these are elderly residents (http://www.statistics.gov.uk/cci/nugget.asp?id=350). The increase in the number of people living alone is one of the most marked shifts in recent decades, with elderly people, particularly women, the group most likely to live alone (Bennett & Dixon 2006).

The idea of the fridge door as a space for children, and particularly for children's art, cropped up repeatedly. Fridge doors are even promoted as a tool for good parenting; for instance, Douglas recommends putting children's drawings on the fridge to enhance their self-esteem (2002, p. 63). In this way, the fridge is reframed as a site for celebrating creativity and accomplishments, which helps locate children in the kitchen as active agents, not just objects of supervision or recipients of care. In the Rowles's household, Abigail's main regret about replacing their conventional fridge with a Norcool model was losing that magnetic surface. "We can't put our children's pictures on the fridge anymore," she said a little sadly:

> I'm sure it sounds really silly, but that's one thing you actually miss. The children do actually like playing with those magnets. … One of the latest things are these little magnetic Barbie dolls with outfits, and these little girls absolutely adore them. We bought one for a friend and I thought, 'I do hope they haven't got a built-in fridge with a wooden surface like ours 'cause they won't be able to use it!'

Peter's favourite fridge magnet was one in the shape of a telephone with a button he could press to make it ring. "Do you still play with that?" asked his wife. "Every now and then," he replied. Clearly in the Templeton household, the fridge door is not a play space exclusively for children.

Many of the Templetons' favourite photographs of family and friends filled the fridge door, or at least they did until Grace recently removed them for safekeeping because they were getting damaged and she was worried she had lost the negatives. Displaying photographs is a common strategy for 'housewarming' and for symbolically gathering family, especially those at a distance (Rose 2003, p. 5, 11).[66] Maschio analyses the refrigerator as a ritually marked object and describes typical hierarchies of display, such as placing pictures with high emotional significance (children, pets, close family and friends) at eye level on the front of the fridge. In his research he observed that:

> a process of creating or recycling family history, of outlining degrees of intimacy or of distance was spatially diagrammed on the refrigerator (Maschio 2002, p. 8).

66 Rose (2003) notes that virtually all the work of displaying, storing or circulating family photographs among friends and relatives is performed by women. This is in keeping with the tendency for the social and emotional labour of maintaining family or sustaining social networks to be women's work.

The decoration on the Hägens' fridge door frequently changes as the three daughters add and remove items or move things around. Ruth is trying to keep the new fridge a bit less crowded than the previous one, something made a little easier now that the two oldest daughters are away at university. She told me that for a while the girls had filled the door with baby pictures, since replaced by postcards and cartoons; Ruth read aloud from 'Gabriel's discovery of postmodernism,' posted on the fridge in a nod to their mother's academic work. Style and colour were important considerations when the Hägen family bought a new fridge the year before I visited. Their preference was to get a silver one but the deciding factor was whether or not it would hold magnets; "For Cassie, our youngest daughter, that was *absolutely* crucial. There were other of these silver looking fridges that wouldn't take magnets but we couldn't get one of those." Finding a fridge with the qualities they were seeking – a 'stainless steel' look but with magnetic capabilities – meant ruling out materials like aluminium or stainless steel, which are not magnetic due to their high nickel content:

> The nickel content effectively foils using the fridge as a family message board. This may be an obstacle for the huge percentage of American families – some estimates put it at 90% – who treat the appliance as a communication center. … [C]onsumers deep-seated need to post Dear Abby columns and pictures of their cats on the refrigerator prompted manufacturers … to introduce lines of faux stainless steel (Hopkins 2005).

The association between fridges and magnets was as strong for Cassie as the link between fridges and food. Having a magnetic surface in the kitchen was not something she was willing to forgo. The whole Hägen family spend a lot of time in the kitchen, eating, working, reading, checking email and entertaining visitors around a huge wooden table. The large silver fridge is visually quite prominence in the kitchen and provides an informal space of display that has become integral to this day-to-day living area.

During the course of our conversation, Ruth sounded especially interested in "all these symbolic aspects to the fridge, the way it does kind of become the focus of the room." Maschio argues that:

> The refrigerator increasingly has become a sort of billboard advertisement for many strongly held values about what a home should be, what sort of emotional and moral tone should distinguish it, and how it should run (2002, p. 8).

That is not to say that all fridge doors are, or should be, thick with decoration; indeed, clean and clutter-free surfaces make equally strong statements about values and priorities. The Templetons' fridge had been covered in pictures and magnets, so much so "it got to the stage where you couldn't see the fridge for things on it," said Peter. When Grace took down the photos, she also got rid of some of the magnets. "We now have it pure and pristine," Peter laughed, with just a few well-chosen items remaining. Grace told me, "I'm moving, imperceptibly as far as other people are concerned, into a more organised phase." Her explanation hints that the recent clearing and reorganising of the fridge door was symbolic of a broader search for order in her life and represented an outward expression of efforts to remake herself as a more organised person.

Dorothy's fridge is magnet free. She thinks it is 'tacky' to have too much stuff on the fridge, preferring to maintain its clean, uncluttered appearance. Lisa was more forthright. "I *hate* fridge magnets. Magnets are for morons!" she declared, rolling her eyes. Her values are expressed in the décor and arrangement of her home, where her preference is for functional rather than ornamental items. In her view, fridge magnets are 'pointless' and a waste of money. Her current fridge is very small and located in a cupboard in the hall, some distance from the kitchen. As such, it does not lend itself to decoration, but were she to have something on the fridge she thinks fridge poetry would be a better use of a big blank space, perhaps in Spanish to help improve her language skills. Lisa's hypothetical fridge door would be functional not frivolous, a learning space rather than simply something decorative. Maggie and Simon have a few fridge magnets, accumulated unintentionally over the years. Not something that either would deliberately go out and buy, magnets are things that 'drop into their laps' from time to time, things that literally "fell out of Christmas crackers" or were given to them by friends and found their way onto the fridge. Despite having given little conscious thought to the topic of fridge magnets, Maggie and Simon knew the basic rules. They were never in any doubt that the fridge was where these items were meant to go: "it's just what you do." While the organisation of every fridge door will be individual, all draw upon a shared social repertoire. The pervasiveness of the practice prompted Mike to speak of "fridge-magneting," subconsciously converting the term into a verb to denote a practice that has become sufficiently established to have developed a market for 'magneting' accessories. My point here is that, irrespective of whether people love, loathe or remain indifferent to sticking things on the fridge, Britons have come to consider this an entirely normal practice, even if it is not one they choose to participate in themselves.

The idea of 'the fridge door' now has common currency. As it became naturalised as a display space, the fridge's association with creativity and communication started to seem self-evident. Built upon the scripting of the fridge as communication centre comes 'the smart fridge.' With its internet connection, email access and touch-screen integrated into the door, Electrolux (2002) describes the door of this latest incarnation of the fridge – a hybrid fridge-computer – on the basis that:

> The natural place for communication in every family. … [T]he fridge is where the kids come home and look for snacks, so it's a kind of natural place for … the electronic equivalent of the scribbled messages held in place with fridge magnets.[67]

This social dimension of the refrigerator was born out in Electrolux's trial of the Smart Fridge in fifty homes in Copenhagen in 2001:

> Many test subjects found the smart fridge morphed into a popular combination of breakfast table, newspaper, and meeting center. … Instead of offering cooking tips and facilitating e-commerce, as first envisioned, the smart fridge evolved into a family meeting point where dads checked the morning traffic, moms listened to the morning news, and kids left computerized Post-it messages. "When we started, we thought this was about shopping for groceries online," says Henning Thomsen, a 34-year-old participant and a technology analyst at the Danish Technological Institute. "It ended up being for everything except that" (Echikson 2001).

As a kind of 'bulletin board,' electronic or not, the fridge door functions as a memory tool. Both past- and future-oriented, it is a reminder of friends and family, of tasks to do, of things to aspire to or take comfort in. In many ways, the fridge door 'maps' a moral economy of the household. Readily co-opted as a site of self-expression and symbolic construction of family, it depicts social and familial networks, articulates values and acts as a vehicle for the transmission of social knowledges. Following its initial domestication as a cold control device, I argue that the appropriation of the refrigerator's exterior surfaces for communication, creativity and display represents a secondary act of domestication, making the refrigerator a technology that has been doubly domesticated.

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67 Electrolux's prototype ScreenFridge premiered in 1999, but LG's Internet Fridge was the first to reach the British market in 2002. Priced at several thousand pounds, sales have been limited so far.

LIVING *WITHOUT* A FRIDGE: THE FRIDGELESS FEW

To gain greater insights into the place of the refrigerator in contemporary Britain, I suggest that it can be highly instructive to turn attention to those who do *not* have a fridge, as well as those who do. Those appliances most normalised in daily life can perhaps be 'seen' most clearly in their absence. Latour, for one, draws attention to the redistribution, 'translation' or 'delegation' of work to things by encouraging his readers to think about the work that would have to be done if a given object or technology was absent:

> Every time you want to know what a nonhuman does, simply imagine what other humans or other nonhumans would have to do were this character not present (Johnson aka Latour 1988, p. 299).

Only a couple of my interviewees could contemplate living without a fridge. As Efia and her family live a few minutes walk from a large supermarket, she reasoned that it might be feasible for them to manage without because they could shop daily. In effect, the supermarket could function as their 'refrigerator,' a large food storage facility just around the corner from the house, rather than a small one inside it. However, she points out that this scenario assumes that a family member – most likely her – would be available to shop every day and questions whether she would have the time to do this. "I wouldn't mind trying to live without a fridge for a while," said Tony Hawks, a man always keen on an unusual challenge. "It would make you go out and buy fresh things, eat them and then go out and buy more fresh things." Tony had been a guest on a BBC Radio 4 programme in 2002 along with Clarissa Dickson Wright, one half of the celebrity chef duo from the BBC television cooking show *Two Fat Ladies*:

> She was saying they're overrated, that people didn't used to have fridges and we don't need them, you know, that we rely on them far too much. She was quite anti-fridge actually, and quite interesting in that, … as a chef, she was saying 'I don't think we need a fridge.'

To Janet Cooper, a fridge is an essential technology and to live without one would be a struggle. "It would take a lot of my life away," she commented, recalling the endless labour of shopping, carrying, cooking and conserving that she grew up watching her mother perform. Grace Templeton spoke for many when she said: "I can't imagine life without a fridge." I close this chapter by turning to case studies of two families who did imagine precisely that and who live, by choice, without a refrigerator: Carrie and Bill Anderson and their five children in

Norfolk; and Frank Evans and Claire Ashley and their two small children in South Wales. While their situation would have been entirely normal just a generation or two ago, it is now considered decidedly odd. As Carrie commented, “we were thought of as being a bit wacky.”

Carrie and Keith and their very cold kitchen

Carrie and Keith Anderson live in a late eighteenth-century cottage in rural Norfolk. They have five children, a nine year old who lives with them and four older children in their twenties who have now left home. Their house was semi-derelict when they bought it. The elderly man who lived there previously had a very rudimentary kitchen, little more than sink on a trestle with no running water. The only water came from a cold tap in a basin on the upstairs landing so, in order to cook near the water supply, the Andersons set up what they referred to as a makeshift “semi-kitchen” upstairs and used a Calor gas cooker in a bedroom for cooking and for heating all their hot water. For the first few years, until they installed a more permanent kitchen with a woodburning stove to heat the house, they lived in the one downstairs room that had an open fire and cooked and slept upstairs.

Carrie was pregnant with their first child when they moved in and the couple had three more children within a space of seven years. In retrospect, she marvels at how they coped in such basic circumstances with four young children and very little money. It was only in the last year that they got connected to the gas mains and bought a gas stove, to eliminate the need for them to haul the heavy Calor gas cylinders into the house every month as they get older. They do not have central heating but are open to installing it in future, joking that they may not want to still be chopping wood into their seventies. They have no fridge, and no intention of getting one. When I first spoke with Carrie by phone, she invited me to drop by and freeze in their kitchen for a while to see why they do not need one.

Carrie was not certain how their reluctance to have a refrigerator first came about. Both she and Keith had quite conventional backgrounds. When they first married they lived in rented flats and always had a fridge. In the beginning, it was not a deliberate decision and did not represent an objection to fridges in principle so much as a case of learning to manage as best they could with the bare minimum. Carrie told me:

> It was all necessity and what we could afford and what we really needed. Those things don't matter when you've got children's shoes to buy and things like that.

Buying a house of their own and starting a family offered them an opportunity to think about their values and about how they wanted to live. Their most pressing priority was always to feed and nourish the children. They never found themselves the least bit interest in "being consumers" *per se*, or in accumulating household goods, and their recent experience of shopping for a new gas stove bored them utterly. Carrie found that they soon got used to managing without a fridge; "we just jogged along with what we had and what worked." Moreover, they began to see the merits of not having one and she highlights four main reasons why they chose to remain fridgeless:

> We made a fairly deliberate decision to avoid, well, first of all bills. So it was a matter of cutting electricity and things like that. … The fewer things that we had to plug in the better as we never had a huge income, ever. … There also wasn't the room. This is the largest room in the house. It became the family room and I didn't want it full of white shiny things … because we live in here, the children are always in here, so I didn't want it to have a domestic appliance sort of feel about it. And frankly, it's so cool on the kitchen floor and I have a marble slab on the floor. … Even with the stove going it's warm in here but the floor's still cold, the butter's still hard.

Thus, electricity consumption and limited kitchen space were two primary disincentives. Thirdly, they saw the kitchen very much as the hub of their home. As a place where the whole family spent a lot of time working, playing, reading, doing homework and socialising around the large kitchen table, they were reluctant for the space to be dominated by appliances. Lastly, the cottage has no central heating so 'room temperature' is lower than most houses and its physical construction enabled them to achieve adequate cooling without any need for artificial refrigeration.

During one summer heatwave, Carrie's sister felt sorry for them and bought them a portable fridge/cooler. They relented and plugged it in, but just the once. They found the noise excessive and Carrie has since given it away.

> We don't really like humming things. They do hum. … People accept a certain amount of buzz, neon lights, things like that. … Appliances, I don't like the noise. Plus, they go wrong. You get used to having them and they go wrong and you haven't got them and you've got no back up.

To her, a fridge was just one more thing upon which she was liable to become dependent and by which she risked being let down. Much of the Anderson's motivation stems from a desire to be as self-reliant as possible. They generally regard 'low-tech' methods as more reliable than the sophisticated technologies to which most Britons are now accustomed. They prefer not to be overly dependent on electricity. This keeps their bills low, plus, if the power goes out, it does not present a crisis. Keith mentioned occasions when his parents had to come and stay because power cuts left them with no heat or light. At Keith and Carrie's place, the absence of electricity makes minimal difference for they cook by Calor gas, heat the house with a woodburning stove and face no risk of food spoiling from a fridge or freezer breakdown. They simply resort to candles for light. Carrie would also be quite willing to light a fire and cook outside if necessary. It might be unconventional but "it's not the end of the world," she shrugs.

Frank and Claire: disconnecting (from) the fridge

Frank, Claire and their two pre-school children live in a community of mostly self-built homes 'off the grid' in rural South Wales. The chalet they have rented for a little over a year has a Calor gas cooker but mostly they cook on the wood-fuelled Rayburn that also heats their home. They listen to a wind-up radio, power a computer from their generator, but choose not to have a television. A year ago, they bought a second-hand washing machine with the intention that it could be a communal one shared with neighbours, only to discover that their generator was not quite powerful enough to run it. Frank is happy to wash laundry by hand instead. It is something he finds satisfying and he highly recommends it as good exercise! He argues that handwashing uses less water and energy and, by keeping on top of it and washing little and often, is actually quicker than washing by machine. Friends living nearby have a washing machine that they use from time to time, which is what Claire prefers to do. The couple also have a car-sharing arrangement with these friends, enabling them to strike a balance between having access to a car when they need one without falling into the habit of using it all the time.

Claire was raised in Canada by what she describes as hippie parents. They did not have consumer electronics such as a television, video recorder or stereo, though they always had a large fridge. Before moving into their current house, Claire had had a fridge for her entire life. She joked that she experienced the opposite trajectory to most people, having grown up with fridges "six foot high – in Canada they're huge, just massive," and then scaled down to "little knee-high ones" when she moved to Britain, and now to nothing at all. Frank grew up in a family that was reasonably politically and environmentally aware, though fairly conventional in their consumption practices. The transformational period in his life was the year he spent living with fellow protestors on an anti-road protest camp. The group constructed an elaborate network of interconnected treehouses out of reclaimed materials and cooked and ate communally, living on surplus food. It was here that Frank learned how to house himself and how to live in a low-impact way:

> I'd lived for a year without paying rent, building my own place, providing everything for myself, managing without a fridge, you know. You realise you don't need all of that stuff.

Subsequently, Frank spent two years living in a bender that he built in a nearby woodland.[68] By putting his new-found skills into practice, he was able to live simply and cheaply while he completed his graduate studies, or at least he did up until he got evicted from the site; because his bender lacked planning permission it was not a legal dwelling. He and Claire then lived in Canada for three years, where their children were born, before returning to Wales.

Some households in Frank and Claire's community do have refrigerators. As none of the houses have access to mains electricity, these fridges are absorption models powered by Calor gas. In fact, the house they rent does actually have a fridge installed but, for environmental reasons, they elected not to use it. Frank tells me, "the first thing we did when we moved in was turn ours off." He explained his rationale:

> I try and live sustainably and try and live in a way that everyone on the planet could live …. I think everyone on the planet can't have their own fridge. I don't think that's sustainable.

68 A bender is constructed by creating a frame out of coppiced poles of willow, ash or hazel. The poles are bent into an arch, secured together, and a tarpaulin is then stretched over the top. Frank built the structure on a pallet base and over time added extra comforts, like a wood stove for cooking and heating, carpeting, windows that he salvaged from skips and solar panels to power electric lights.

Only when appliances can be produced with a sufficiently low impact, using materials that do not have such high embedded energy, does he think it would be feasible for every family to have one. He spoke of friends in Germany who use a very small fridge powered by a solar panel:

> That's a low-tech one I could see us having. But, to be honest, for most of the year you don't really need it. That's the crazy thing. We've got all this energy going into fridges and there's that thing that once you've had them, then its your norm and you expect them, or think it's your 'right' to have them.

Frank finds these norms and expectations highly problematic and sees real dangers in the normalisation of such 'hungry' appliances. "I *hate* being around a fridge in a kitchen in someone's house, it's like urgh!" he shudders. For most people, the appliances and electronic gadgets with which they are surrounded are so familiar that they become almost invisible. In contrast, Frank remains acutely aware of such objects sitting in people's houses quietly consuming power day and night. He feels fortunate to be living off the grid as he believes the national electricity network to be highly inefficient, but his ideal would be to live in a low-impact development where renewable energy systems generate power collectively and where a couple of computers, washing machines and a large chest freezer could be powered and used communally. It is not that he rejects these technologies altogether, but he sees compelling reasons why such resources are better shared, rather than duplicated in every household.

Having lived in their current home for over a year and closely monitored their gas consumption, he feels they could justify switching on the fridge for a couple of weeks in the height of summer. They have used only one bottle of gas in a whole year "and we would have used way more than that on the fridge alone if we'd had the fridge running." Although no longer a designated cold space, Frank and Claire's disconnected fridge still functions as a storage unit; they use it to store egg boxes and plastic bags (Figures 5.5 & 5.6), just as they used the dishwasher when they lived in Canada with Claire's father. This practice is somewhat akin to the 'misuse' that Housecraft Advisor Ann Smith observed in the previous chapter when she discovered housewives in council flats using their new refrigerators as mending cupboards (DoRDeC 1957c, p. 5). They, like Frank, were doubtful about the wisdom of using a refrigerator, unconvinced about the necessity of having one or wary about the cost of running one twenty four hours a day. But where these early users may simply have misunderstood the concept, Frank is fully conversant with the conventions of 'appropriate' fridge use. He simply chooses to reject them. Resisting dominant food storage practices, he deliberately 'misuses' the fridge, judging its costs, both economic and environmental, to be too high.

Figure 5.5 The disconnected fridge

Figure 5.6 Refrigerator as storage cupboard

Source: own photographs

Resource use was certainly one factor in both couples reaching their decision to live without a fridge. Both seemed to enjoy the opportunity to test their ingenuity by finding alternative ways to store their food. Above all, though, they simply came to the conclusion that a fridge was not something that they really needed, largely because of what and how they eat.

'Bobbly milk' and 'sneaky meat': relationships between diet and refrigeration

I was curious whether food storage had been a challenge for Frank when he was living in his bender, but he claimed it was not something he found difficult; he simply let go of the expectation that perishable food could be stored for long periods. He thought of it as returning to a mode of living that would have been the norm in the not too distant past. “It was never an issue. That’s what people used to do, isn’t it, they just used to shop more regularly.” Now, every three months or so, Frank and Claire put in a bulk order for dried goods such as beans, rice and flour. Frank is involved with a nearby organic farm, from where he gets fresh vegetables. They supplement these with produce from a monthly farmers’ market and buy additional groceries locally as needed week to week.

Carrie’s shopping habits altered a few years ago when organic food started becoming more widely available in supermarkets. She now does a big weekly supermarket shop, rather than “dotting around all sorts of places” as she had to in the past. When the children were young she used to buy ingredients in bulk from a cooperative and cook almost everything from scratch, but since returning to work part time as a radiographer her cooking practices have changed. “It was a very labour-intensive way of living. … I must admit I’ve eased off since I’ve gone back to work.”

The Andersons’ diet centres around fresh food. Keith grows all the family’s vegetables in the garden and in an allotment across the street. He had no particular interest in gardening initially, but he and Carrie decided to grow their own food when they started a family because it was the only affordable way to feed the children organically. Keith used to be a painter and decorator until a medical condition forced him to stop work. Once the major renovations on their house were complete, he turned his attention outside and his job became running the garden full-time to keep the family self-sufficient in fruit and vegetables year-round.

Carrie enjoys the seasonality of what they eat, the taste of different things at different times of year, something she imagines many people have lost as the year-round availability of produce flattens seasonal variation. Her approach to planning meals is to go and wander round the garden and create something from the food she gathers fresh; “there’s always half a dozen different things I can go and get out of the garden. I just see what’s there and what looks good.” Their practice of consuming directly from the garden substantially diminishes the Andersons’ need for interim food storage. Refrigeration is largely redundant when vegetables are eaten within hours of picking, rather than the days or weeks or months for which commercial produce may be stored. Keith and Carrie’s garden functions as a living storehouse so there is little need to artificially prolong the shelf life of this food in a 'holding space' like a refrigerator. Carrie comments:

> I mean, the whole fridge thing really all boils down to the fact that we just eat what there is at each time of year, and eat fresh. That's really all there is to it.

"I was vegan for seven years so I didn't need a fridge," Frank said in passing at one point. To him, the link was obvious but his comment helped to highlight for me how profoundly people's diets influence their need for refrigeration. He, Claire and the children were all vegan for a time, but as the children got a little older they started eating cheese and meat. Their shift in diet was accompanied by a parallel shift in their cooling requirements. Claire emphasised how much easier food storage had been when they were vegan:

> because most of the things you buy don't need to be refrigerated. You only have a handful of things you need to watch in terms of preservation, rather than practically *everything* in your kitchen if every meal is based around some dairy or meat product. Now whenever we have milk it's really frustrating to me whenever it goes off, because we don't have a fridge and that's why it goes off. And it really frustrates me that when we buy meat we've got to eat it all in just a couple of days. It's cool outside now, but in the summer we would have to eat it that night or put it in our friend's freezer.

They buy organic meat from the monthly farmers market, but the challenge of preserving it without a fridge restricts them to a window of just a few days when they can safely eat it. This period of time is intimately tied to outside temperatures in a way that would be unimaginable for most Britons now. Frank acknowledged that having a fridge or freezer would enable them to eat small amounts throughout the month, but he is happy to eat meat only occasionally as that way it feels like a special treat.

The Andersons were vegetarian for twenty-five years, but now that supermarkets stock organic meat they started eating it again. They remarked that a meat-free diet had simplified their food storage requirements as their only major concern was keeping dairy items cool. Carrie mentioned losing the odd bottle of milk in the height of summer, but on the whole the family learned to tolerate without complaint the early signs of milk being on the turn. "You get used to the bobbles!" she assured me. "Sometimes milk's been a bit bobbly, but I put it through a cheese strainer." Keith is not concerned about keeping vegetable-based foods too long because, as he puts it, "they soon start to advertise their presence!" Carrie agreed, "vegetables are obviously off, aren't they. There's no doubt about it." The two argue that visual and olfactory cues make it easy to tell when vegetables should not be eaten but Carrie notes that meat is more problematic as it may give no outward signs of its condition. “With meat, it’s a bit sneaky isn’t it? It doesn’t always look horrible.”

What emerges very clearly is that the need for a refrigerator closely corresponds to a diet high in animal protein. When Mike McFadyen was describing the fridges installed in postwar prefabs he stated that “a refrigerator held these basic things: butter, eggs and milk. Dairy products.” This is why those who eat primarily fresh food, and those who consume little or no meat or dairy, are likely to have less need for a refrigerator.

Storage methods: ‘low-tech’ technologies of preservation

Both couples showed me round their food storage spaces and talked me through the preservation strategies they use. Each has created or appropriated different degrees of cool space distributed inside and outside the house. Frank pointed out that their kitchen countertop is tiled, which helps it to stay a little cooler than other surfaces. Bread, cheese and eggs are kept out on the counter for convenience. He and Claire buy cooking oil in bulk and store it in the cupboard below the counter, a cool dark space which also has a tiled floor (Figure 5.7). Any food left over after meals gets used up the following day. They generally leave it in the pan and put it outside overnight, on the concrete path just outside the door where it is sheltered from the rain. Outside, opened jars sit in a dish of water and potatoes are stored in a sack, kept dry inside a plastic bin. Next to these is an abandoned fridge that Frank found in a lane and brought home to use as a cupboard. Although it provides a well-sealed storage space, invaluable when they are worried about attracting rats, they found it is not really suitable for storing food because it has no ventilation so they only use it occasionally (Figure 5.8).

Figure 5.7 Cool kitchen cupboards and surfaces

Figure 5.8 Frank & Claire's outdoor food storage spaces

Source: own photographs

When they buy meat it either goes inside a cool box by the door or they use a method adopted from friends in Australia. There, prior to artificial refrigeration, one technique for preserving food was using a 'coolgardie safe.' This involves draping a wet hessian sack over a frame; the water evaporates and keeps the contents cool. Frank improvises on this method by wrapping meat in a cloth, putting it inside a wet cotton bag and hanging it from a hook on the side of the house (and in so doing finds an ingenious end-use for something that begin life as a Royal Geographical Society/Institute of British Geographers conference bag!) (Figure 5.9). Frank and Claire sometimes cool things in the kitchen in a pan of water with a damp tea towel draped over the top, but most of their perishable food is stored outside. "That's Claire's argument for having the fridge on," Frank explains, "so that we don't have go outside all the time." In practice, Claire finds she misses having a freezer more than a fridge, "because you can make *cool* space, but to be able to *freeze* things is such an easy way of preserving food long term."

Figure 5.9 Frank's meat preservation device

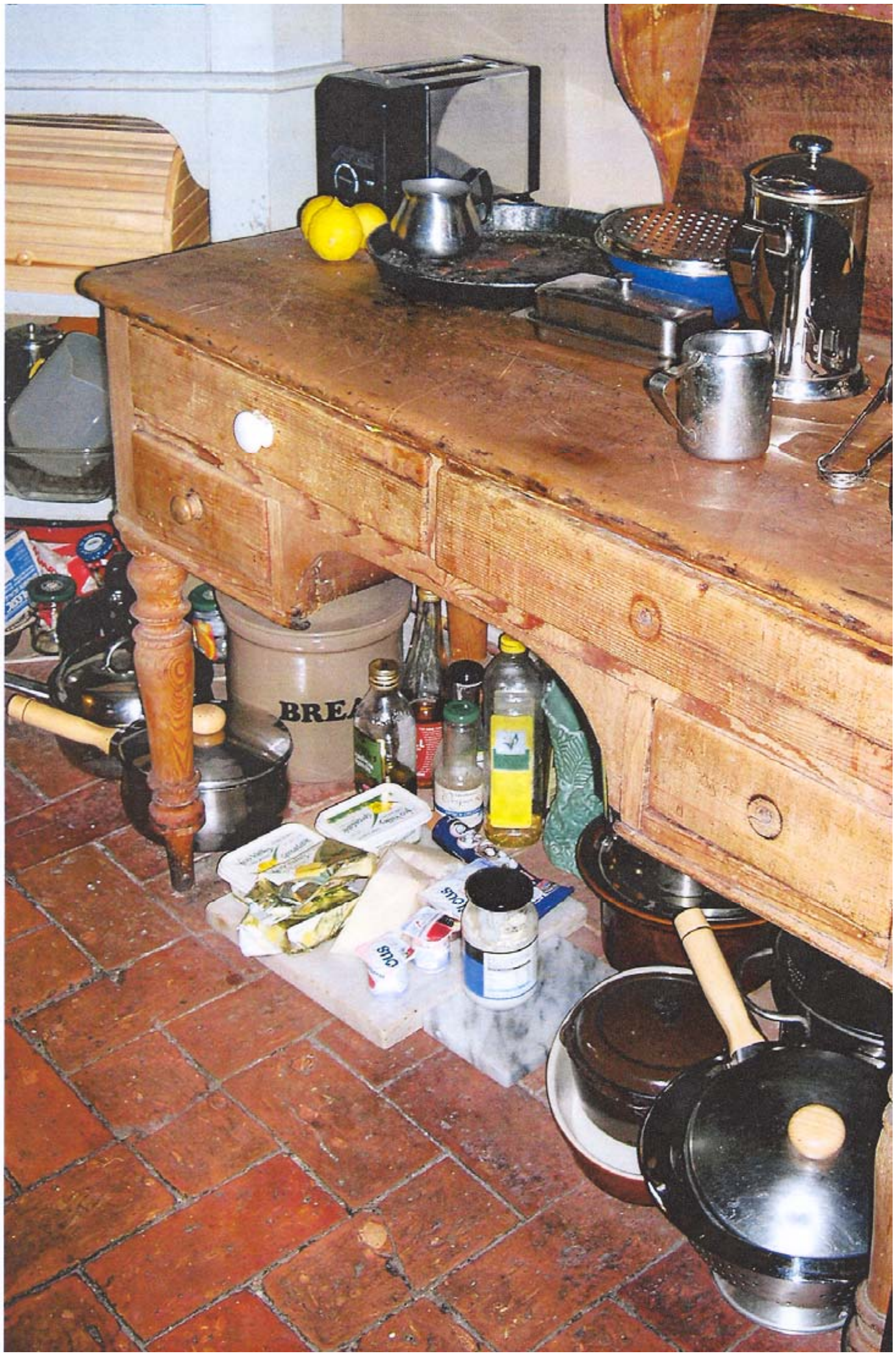
Source: own photograph

For the Andersons, on the other hand, the kitchen floor provides their primary cooling device, thanks to the methods and materials from which it was constructed. The floor is tiled with pamments. As the house was built before damp-proof courses were introduced, the pamments are laid on sand directly on the ground. Damp-proofing started to appear in houses in the mid-eighteen hundreds and was made mandatory with the passing of Britain's first Public Health Act in 1875. Since then, building regulations require that all new dwellings have a damp proof course. Today, this usually takes the form of a polythene membrane laid at ground level, though earlier methods included layers of tar and sand, dense bricks made from low absorbency clays, bitumen or slate. Most building materials are porous so this barrier prevents moisture seeping up from the ground by capillary action. Houses built prior to the Act are often prone to 'rising damp,' which can seriously damage walls and woodwork. Adequate ventilation helps this moisture evaporate and minimises the problem of damp, which is why older houses can be somewhat draughty. Damp-proofing and draught-proofing may make modern houses warmer and dryer than the Andersons' cottage, but the *absence* of an impermeable seal between floor and ground, between inside and out, is advantageous to them in their particular circumstances. The sand beneath the pamment floor absorbs moisture from the ground and keeps the tiles cold, even when the room is warm. Rather than being insulated from the earth's dampness, the Andersons are able to actively exploit it for cooling food in lieu of a refrigerator.

Tucked beneath a dresser, directly on top of the pamments, lies a marble slab on which they store the foods that need to stay the coolest (Figure 5.10).

> Keith: That marble slab we put food on. It's always several degrees colder than the surrounding air. It's a physical property of marble, so it has a cooling effect. …
> Carrie: There's mayonnaise, yogurt, cheese and butter down there, and then I've got some soup that I made yesterday, which I've also got down on the floor there because I always make my soup based with butter, and porridge too, as that's made with milk.
> me: And those things [in the saucepans] will be stored for how long?
> Carrie: Well, they'll be gone by the next day.
> me: So you don't tend to have things hanging around?
> Carrie: No.

Figure 5.10 The pamment floor and marble slab: Carrie and Keith's 'fridge'



Source: own photograph

Bacon is stored on the marble slab too, now that they eat meat. Carrie imagines that, if well sealed, it should last for a couple of days, though she does not like to keep it around much more than a day.

> We did have problems with the turkey at Christmas. … I'm fanatical about eating it up as quickly as possible, I boil up the bones the same night and we have soup the next day and that's it. … We'd never have it hanging about, no.

The question of what to do with leftovers was rarely an issue in the Anderson household; "you're very lucky with five kids to have anything left over," they laughed. The reason why their seemingly primitive storage methods work so well for them is because food storage is usually a short-lived affair in their home. They eat fresh produce, they consume food quickly and they do not allow things to linger for long.

Another cooling device can be found outside the door. Here, Keith has set up a large earthenware flower pot in a tub of water with a saucepan lid on top. He tells me it is modelled on a technology that has been used around the world since at least the time of the ancient Egyptians (Figure 5.11). They use it to keep their bottles of milk cool, now that the local dairy has reduced milk delivery to every second day. Water is drawn up into the flower pot and evaporates, absorbing heat from the interior of the pot and thereby keeping its contents cool. A strategy the family use on camping trips is to dig a pit, line it with a plastic bag and put a cover on top. Inside, their food stays cool. During a heat wave the previous summer they did contemplate constructing something similar in their garden lined with pamment tiles. Like Frank and Claire, Carrie also uses the technique of keeping food containers cool by sitting them in a bowl of water with a wet tea towel on top. She finds it to be an effective method because the hotter the temperature gets, the more the water evaporates and cools the food. Even better, it does so without the need to plug anything in or pay any electricity bills.

Figure 5.11 Earthenware milk bottle cooler

Source: own photograph

The Andersons generally avoid the need to refrigerate food by eating fresh from the garden. Most of what they store is produce harvested from the garden and dried or otherwise preserved, one advantage of dried foods being that most keep well at room temperature. Keith also collects his own seeds to plant again the following year. On the kitchen table lay a pile of red peppers and cobs of corn and Keith showed me bags of dried beans ready to cook or to plant next spring. The entrance hall is unheated and they use it to store vegetables that benefit from being kept in a cool dry place. There were onions loosely piled in a cardboard box and potatoes packed in sacks, still covered in mud to help preserve them. So long as the ground does not freeze, hardy vegetables like cabbage, beets and greens can overwinter in the garden so, even though the plants may stop growing, the garden continues to act as a storeroom from which Carrie and Keith can gather food year round.

Thinking outside the cool-box

Both couples comment that their choice to live without a fridge is something other people find hard to understand. When Claire's mother visited from Canada she offered to buy them a fridge, unable to comprehend how they coped without one, particularly with young children. It strikes Frank that his decision not to use a fridge can be profoundly disturbing to some people:

> People didn't used to have fridges … but now, to suggest not having a fridge is sacrilegious because it's really going against what our society is about, the idea of progress and civilization. For some people it is actually quite a challenge to their basic beliefs to suggest that we can live without fridges or we should live without fridges.

That they should choose to do without an object so commonplace and 'normal' seems to disrupt some people's sense of ontological security. Carrie expressed her frustration at how often visitors come to the door and, trying to be helpful, bring in the bottles of milk delivered by the milkman:

> They go: 'I've brought your milk in.' I go: 'it's freezing out there, leave it out there!'… It's amazing the number of people, because that's what you do in the morning, you go outside in the freezing cold, pick up your milk and bring it inside to the warm!

In a culture where having a fridge (and doorstep milk delivery) is normalised, this action becomes habitual. Outside temperatures are irrelevant when the 'proper' place for milk is in a refrigerator. Carrie's 'helpful' visitors are always startled to learn she does not have a fridge, as most cannot easily comprehend being without such a taken-for-granted appliance; as something so pervasive in British culture, it is easy to assume that everyone must have one.

Without a fridge, Carrie and Keith have become attuned to reading their immediate environment in a way that differs from their peers. By exploiting temperature variations produced by non-mechanical means, they have learned to 'see' cool spaces in a way that others fail to notice. Zerubavel points out that ignoring is a highly normative practice because it involves making choices about what deserves attention and what does not (1997 p. 49-50). To a refrigerator user, such practical knowledge is no longer valuable and can safely be ignored. The Andersons' methods of provisioning and storage, however, draw upon different ways of seeing and different ways of thinking. Carrie comments that "the milk comes cold in the morning and [needs to] stay cold and at this time of year obviously 'the fridge' is outside." Her 'fridge' is produced through a mobile and flexible set of tactics. It is at once the garden, the cold pamments, the floor without a damp course or the dish of water. Its creation depends upon being able to think, quite literally, outside 'the box.'

Neither Carrie nor Keith had an overtly anti-fridge stance at the outset, just a growing realisation that mechanical refrigeration was not something that they really needed. However, over the years, Carrie has found that pressure from others has fuelled a greater resistance to having one. "The number of fridges I've had pressed on me!" she exclaimed, resentful of the implication that she should alter her preferred domestic practices to ease other people's discomfort. "I think not having a fridge strikes people as an odd thing because they can't imagine their lives without it." She described her mother becoming increasingly technological as she got older. Once a stay-at-home mother who cooked everything from scratch, over time her mother embraced the full range of kitchen technologies and could not understand why her daughter would not choose to do the same: "She used to look at me and ask, 'why are you still doing this when you don't have to anymore?'" The food storage practices that Carrie, Keith, Frank and Claire engage in are little different from those with which the chapter began, but their context has changed utterly due to the 'career' trajectory of refrigeration as a domestic practice. Once unremarkable activities, they now strike people as anomalous, bizarre or, in Frank's words, 'sacrilegious' even. Living with a fridge is the convention. The expectation is that this is what one *should* do. Both couples find themselves contending with other people's unease at being exposed to that which is not 'normal'. Shocked reactions to their fridgeless status hints at an ideological belief that to live without a fridge is in some way 'uncivilized.' That fridgelessness should be such a troubling state indicates that the refrigerator has not simply become a familiar and accepted part of domestic space, but something underlying its very constitution. Although the category of 'technology' has traditionally been positioned in opposition to notions of 'home' and 'domesticity,' I suggest that contemporary British domesticity *requires* artificial refrigeration and that a home without a fridge is now *unheimlich*.

Chapter 6

The ELF, the Mountain and the Museum: The Life of a Fridge after Death

FRIDGE TROUBLE

I did my best not to choke on my tea when His Honour Judge Templeton suddenly crouched on the floor to demonstrate the art of DIY fridge repair by showing me how he blows the accumulated 'goop' out of the drainage pipe at the back of his fridge. This chapter turns to fridge-trouble and to the questions of repair, reuse, disposal, destruction and preservation raised in my conversation with Grace, an artist, and her husband Peter, a Circuit Judge:

Grace: We have had trouble with fridges where something, a stray lettuce leaf or something, gets wedged in the little hole at the back where the water drains out. Normally we pull the fridge out and blow up the tube, but last time this happened I decided to try Jeyes Fluid. It's not to be recommended! It smelled for a really long time, ages. So don't do that!

Me: Blowing? How do you actually get at the tube?

Peter: Well down at the bottom at the back there is a sort of drip tube. But if that gets blocked I use my great 'scientific discovery'! I get down on my knees and go like this [*demonstrates*]. It puts a horrible little globule of black gunk back into the fridge, but then you clean the fridge out and then the thing works again.

Grace: I also replaced some shelves recently. That is something that really annoys me, built-in obsolescence. The shelves are always cracking, breaking, and they're *very* expensive to replace. … The plastic snaps when you wipe, if you're not very gentle. … So you stick it together with sellotape, which is really awfully tacky.

Me: So, if you had problems you couldn't sort out yourselves, would you get it checked or repaired, or are you more inclined to replace it?

Peter: We've had repair people out, haven't we, no, actually, not for the fridge.

Grace: No, I think it's been the blowing and the stuck-on coin and do-it-yourself repairs, unless it breaks down altogether of course. … In fact we're just about to get our third 'back up' fridge down in the cellar. The first one died very dramatically and plumes of gas filled the whole house. … I don't know whether you've smelled the smell of what comes out of a fridge. It's very acrid and *terribly* unpleasant.

Me: How dramatic! How long ago was that?

Grace: The 'great happening'? It must be twenty years ago. We had friends staying up in the attic and they came coughing and spluttering down the stairs. … And then we had another one which has just given up the ghost. We were at Bennett's [an electrical store] just yesterday and we've got a new one coming on Thursday.

Me: Have you actually got rid of the old one yet?

Grace: No, the man from Bennett's will take it away when he brings the new one. We had to pay £40 extra because they have to pay someone to take them away.

Me: Have you heard about the new rules for recycling fridges?

Grace: I'm not very aware. I now know that they go to a company which gets rid of the gasses in some safe way. Don't know what it is though!

In this chapter, I ask what happens when fridges fail and follow the journeys of refrigerators through different spaces, different stages of their lifecycle and different categories of meaning. My interest lies in their physical and conceptual mobility and in the various kinds of knowledge bound up in their trajectories. The 'ELF' to which the chapter title refers is the acronym for an end-of-life-fridge. Much of the chapter deals with what happens when a fridge 'dies,' dramatically or otherwise. Like Grace, few people are aware of where their refrigerators go when they are thrown away. She has a vague awareness that there are some difficulties with disposal and that fridges have to be taken away to have the gas removed for safety reasons, but confesses that she does not know exactly what or why this is. It is something she learned of only recently when she replaced a fridge and discovered there was now a charge to pay to have the old one removed. My aim in this chapter is to pick up from where Grace left off and fill in the rest of the story. To do this, I follow refrigerators through paths of repair, reuse, recycling and disposal. I ask where they go, how they get there and what happens to them.

I begin with 'repair knowledges' and explore the knowledges and practices used both in a professional capacity and in the amateur 'DIY' approach the Templetons adopted. I explore a key moment in the disposal of refrigerators that arose in 2002 when European legislation profoundly reshaped the routes and visibility of refrigerators in Britain and trace the developments in scientific understanding that initiated the change in disposal practices. I then look at the destination of discarded domestic refrigerators and explore the complexity of disposing of, dismantling and destroying these appliances. I note how frequently narratives of 'life' and 'death' came up in my interviews. There was much talk of "dead fridges," of fridges "giving up the ghost" and ending up in "graveyards." Interestingly, death was often not a final state. Fridges could be rehabilitated, change category, slip in and out of 'death.' In the final part of the chapter, I turn to an example of a fridge that escaped the process of disposal and destruction and trace its journey to a museum collection where it will be preserved in perpetuity as an artifact of scientific, technological and historic interest.

Troubleshooting and repair

The Templetons were quite unusual among my interviewees for the extent of the creative 'DIY' repairs they attempted if they encountered problems with their refrigerator. Some of the strategies they used were reasonably straightforward, such as when Grace, frustrated that they are not designed to be more durable, mends broken shelves with adhesive tape. Functional but unattractive, this provides an interim solution until she gives in and replaces them with costly new ones. Others demonstrated more ingenuity, such as the reference to the 'stuck on coin.' The Templetons had recently discovered that, although their fridge was working fine mechanically, closing the door no longer depressed the button to turn out the interior light, with the effect that the light stayed on, the fridge grew warm and the food began to go off. Rather than calling out an engineer at great expense, they figured out a simple way to solve the problem. They worked out that a £1 coin taped to the top of the door was just the right shape and size to reach the button and were perfectly happy to use this as a long-term solution.

Most fascinating was the 'blowing' technique they use in response to a recurring blockage. Clearly delighted by the success of his method, Peter fondly calls it his "great scientific discovery." Although he uses the term in playful and self-deprecating way, this method does represent an important instance of applying technological knowledges to a problem and theorising possible solutions. Brand's notion that "maintenance is learning" draws attention to the interconnected practical and cognitive processes involved in the work of repair, as well as to the central role played by improvisation in analysing faults and mobilising varied skill sets in their resolution (Brand 1994, p. 127; Henke 2000). Peter assessed the operation of the fridge, determined the root of the problem, concluded that a pipe which lets water out will also let air in, applied some of the basic laws of physics and came up with a creative but unconventional way to rectify the problem simply and without cost. Having learned from their experiment that the technique worked, it has now become a semi-regular practice. Though uncommon in the context of most people's fridge use, pulling out the fridge to blow up the pipe is something the Templetons "normally do," whenever the blockage recurs, allowing them to fend off premature appliance death when there is "still life left" in the machine.

We see Grace and Peter both willing to experiment and to learn by trial and error. The last time she encountered the blockage, Grace came up with an alternative strategy and tried using a strong disinfectant instead. She discovered very rapidly that this method was not effective and caused unpleasant after-effects. She removed some of the shelves to show me the scarring on the back of the fridge where fluid had stained the plastic and described the difficultly she had airing out the strong chemical smell that lingered in the fridge for some time (Figure 6.1). She learned from her experience not to try this again.

Figure 6.1 Grace's disinfectant-scarred fridge

Source: own photograph

Improvising, putting up and making do

Mrs Ladd's very first fridge was second-hand. She described it as "a real old one," a pre-war electric model raised on legs that she bought in 1952, along with a vacuum cleaner and television, when neighbours in Brixton, London, emigrated to Australia. Not yet common in Britain, it was quite some time before any of her family or friends got refrigerators. Their relative rarity at that time made her willing to accommodate its faults and eccentricities. She learned to lift the door a little as she closed it, to compensate for the hinge that did not work, and although her actions were conscious at first, they soon became automatic or 'overlearned,' which, as Ferree (2003, p. 374-5) explains, happens when behaviours like riding a bicycle or playing the piano become unconscious instead of each component of an action requiring active thought or a process of decision making. Even if Dorothy did not fully grasp how the machine worked, she developed a good ear for when the motor sounded 'right,' and when the noise it made spelled trouble. The machine laboured hard to keep cold when the weather was hot and frequently stopped altogether:

> It was a terrible job to get it going. … It used to sort of groan if I had to restart it. I used to lay down on the floor, reach underneath, get hold of the rubber belt and tug it to start it off. Oh, I used to be so on edge, listening and waiting to see if the old fridge was going to go.

Dorothy Ladd laughed at how comical it seemed now, the idea of having to 'jump start' a fridge, but this intervention was a price she was willing to pay in order to have the benefits of a technology to which few others had access at that time. Inconvenient and stressful as it may have been, she grew accustomed to the measures she could take when the fridge did not behave in quite the way it ought. She also recognised when a problem was beyond her capabilities and was far less hesitant than she would be today to call out an engineer. Despite that first refrigerator being old and somewhat unreliable, its relative value was significantly greater than a fridge today. As it represented a large investment, paying for specialist engineering expertise was warranted, whereas the comparative affordability of contemporary fridges in Britain makes people much less inclined to get them repaired.

In 1959, Dorothy and her husband bought a new Kelvinator from a department store in Streatham. They were able to afford it because it was offered at a heavily discounted price from a discontinued line. She described her delight at her new fridge:

> Boy was it a relief to have one that wasn't going to go wrong. When I didn't have to worry about the fridge, or get down on the floor, I thought I was in heaven!

Her confidence in her new fridge inspired turned out to be well-founded for her Kelvinator ran reliably, with no more stress and no more awkward manoeuvres, from 1959 right up until 2002 (Figure 6.2). During that time, the only repair it needed was a new gasket (the seal around the refrigerator door), fitted in 1971.

Figure 6.2 Dorothy Ladd and her 43 year-old Kelvinator

Source: own photograph

Co-producing diagnostic knowledge

To learn more about common refrigerator faults, repair practices and circuits of reuse, I interviewed Mike McFadyen, an electronic engineer in Norfolk who runs a small business servicing appliances, and spent time at Respond, a non-profit company and registered charity in South London that reconditions and sells used furniture, appliances and household items. Mike repairs a wide range of appliances. He estimates that only about one job in twenty is a fridge and comments that "fridges are amongst the most reliable of kitchen appliances because, in essence, they're very simple." Indeed, refrigerators formed one of the largest categories in a competition run by *Which?* magazine, inviting readers to write in about appliances that were still going strong after thirty years, "which rather bears out our usual reliability test result that fridges and freezers are among the least troublesome of all domestic equipment" (Which? 1987, p. 502). Mike walked me through what happens when someone calls him with a problem:

> If your fridge had gone wrong, you'd give me a phone call and I would ask the symptoms. … I interrogate the customer, so it's a bit like medicine really. I have to find out as much as I can and see if it fits any scenarios I've already experienced.

He outlined the steps he takes to try and make a 'diagnosis.' Derived from the Greek *dia*, 'apart', and *gnosis*, 'to come to know,' he mentally dismantles the appliance into its constituent parts while gathering information to try and work out where he thinks the problem lies and whether it can be fixed. His questions lead him through a process of deduction:

> I always say to people, if the light's on, you've got power, that's the first thing. And if it's got power and it's not getting cold, the next thing is to put your hand round the back of the refrigerator. Is it warm? If it's not warm, as remember you've got a heat exchange, then it's not compressing. Then, can you hear the motor running? And if they can hear the motor running and you've got no warmth in the back and it's not getting cold, you've lost all the gas. It's the only thing it can be. So I don't bother to turn out then. I say you need a new machine. So they don't pay for the call providing they give me the information I need so that I can tell them over the phone.

Under Mike's direction, callers perform a series of sensory observations – looking, listening and feeling – and report back their findings. He need not be physically present so long as someone else can act as his proxy to supply the information he requires to make a diagnosis-at-a-distance. Between them in their interaction on the phone, the two bring together Mike's stock of prior technical experience with the symptoms specific to the machine in question.

Navigating with the help of the caller's descriptions, Mike can 'see' the machine as he scans his mental database for similarities with any cases he has dealt with before. Having developed a familiarity with the way fridges behave in certain circumstances, and a technical understanding of what that behaviour indicates, he can draw reasonable conclusions about what might be wrong. In this way, Mike can make a preliminary assessment of the problem before seeing the appliance for himself, enabling him to arrive forearmed with a good sense of the likely causes and the probable solutions. So long as they have the capacity to make the necessary observations, callers do not have to understand the significance of what they are seeing, hearing or feeling. They convey the information. Mike knows what it means.

Technical illiteracy and the economics of repair

The most common fault with fridges is thermostat failure. Fortunately, this is also the easiest to fix with a replacement part. A fridge also relies upon a starter mechanism, without which the compressor cycle will not run. Referred to by Mike as a PTC (positive temperature coefficient), and more commonly known as a 'relay,' this device has low electrical resistance at low temperatures but increases resistance as the temperature rises, before shutting itself off once it heats up beyond a certain temperature to protect the motor from overheating. However, if the motor is running and the user switches the fridge off and immediately back on, many fridges will promptly stop working. The motor must be allowed to cool for ten to fifteen minutes before turning it back on. Crucially, the fridge must also be unplugged to break the connection and reset the mechanism: "As long as it stays plugged into that socket, it will never start again. A lot of people don't realise and a lot of people throw away perfectly good fridges for this very simple reason," Mike told me with exasperation. "Lots of fridges, where someone has just switched it off and switched it on too quickly, go to the tip."

I was surprised to learn that a fridge would need to be physically unplugged then plugged back in before it would work again. I asked how users would be expected to know such a thing. Speaking slowly and with heavy emphasis Mike turned to me and said: "You *read the instructions*. That PTC has to be allowed to cool down, and people don't know that. But it's in the book. *It's in the book*." He was quick to suggest that there could be better ways to convey such a vital piece of information, given that many people fail to read the instruction booklet fully, if at all, and frequently cannot find it when they need it. This gives rise to a profound disconnection between the appliance itself and the directions for its use. Much better, he thought, would be "if it was written on the back of the fridge, something like 'do not switch on and off because the machine will not start,' to explain that it can only start from cold." Only by inscribing it upon the refrigerator itself could one prevent important information of this kind from being detached from the device and getting mislaid. Unaware of the need to unplug their fridge and unable to get it running as a consequence, it is easy for a user to assume that the apparent breakdown is the result of something more serious. Few would think to look to their own actions for an explanation and most would suppose that specialist knowledge would be needed to repair it. Once past its warranty period, people tend to be reluctant to call an engineer, reasoning that a new machine is likely to cost little more than call-out charges and repair costs. Thus, machines are needlessly discarded due to a minor problem but a major knowledge gap.

In Mike's view, much of this problem stems from a lack of technical literacy in contemporary society. "We now live in the *least* technically literate world ever," he believes, arguing that the average Victorian would have known far more about engineering than Britons today, because many would have had "contact with 'real' machinery with gears, teeth and wheels. Everything we have is locked away," he commented; "we don't like to see the works. We like smooth outlines." Products are increasingly designed to close down the possibilities of repair. "They lack any kind of transparency so that their functioning cannot be restored if they break down" (Graham & Thrift 2007, p. 18). With the workings of contemporary machines enclosed, most users are distanced from them, both in practice and in imagination. The majority of people are unfamiliar with how most everyday technologies work. *That* they work is all that is important; few of us feel compelled to know *how*. Divisions of labour in modern society delegate responsibility for understanding machines to 'experts' and technicians. Other than those for whom it is a professional requirement, such 'machine knowledges' are unnecessary for navigating through most people's daily lives.

Mike estimates that well over half of all fridge and freezer faults are repairable; however, frequently repair does not prove economical. Key components like the compressor are sealed and require specialist tools and skills to service. He described the action of the piston inside the compressor, explaining that “every time it goes up and down it’s wearing, and when it gets to the point of wear where it can no longer produce the pressure needed to liquefy the gas, then you throw it away.” A new compressor costs in the region of £45, but the real expense is the labour required to cut the old one away, connect a new one, refill with gas, check for leaks, rewire it and test it. Such repairs are rarely carried out due to the high cost of labour relative to the value of the fridge. Another difficulty with older models is simply that replacement parts are not available. In the past, it was common practice for appliance manufacturers to stock spares for up to twenty years, for that was how long their products were expected to last. Both the expectation and the practice have since changed. Making, storing, cataloguing and administering a stock of components for their entire range carries a significant cost implication for companies, particularly when a proliferation of new models gets released at regular intervals. Manufacturers increasingly work on the assumption that appliances have something closer to a seven-year lifespan and keep parts in stock accordingly. Mike tells me that one thing he has noticed during his years in the business is that some companies now cover themselves for the guarantee period on their products by putting a percentage of their new products aside and simply exchanging them in case of a fault:

> If customers phone up to report a problem, they just give you a new one. They won’t send round an engineer even. They just give you another one because it’s cheaper to send a man round with a new one than to fix it.

The man (and it is invariably a man) sent round with a new appliance comes from a pool of much cheaper unskilled labour than the one with the specialised knowledge they would have to send to fix a broken one. Replacing faulty machines with new ones, and throwing the old ones away, removes the need to maintain a stock of replacement parts; however, one effect of this practice is also to remove the need to maintain the ‘stock’ of human capital, the knowledge and expertise required to perform those repairs. Sustaining that knowledge base is uneconomic, except when concentrated in specialist areas where a premium can be charged. This privileges an economic model of ‘efficiency’ which sees repairable machines discarded and repair knowledges made redundant.

THE GRAVEYARD AND THE SALVAGE MIND

In Britain, a refrigerator is no longer the aspirational appliance it once was. Mike remembers well the moment when the fridge-freezer first came within his reach:

> Mike: When I finally got rich enough, my ambition had always been to have a fridge-freezer.
> Me: Can you remember when that was?
> Mike: Yes, I can almost tell you the day it was! It was 1981. And it's because Indesit produced a range of very good value low cost refrigerators and fridge-freezers. … And they were *suddenly* affordable and people started dumping all their old gear and buying these. So suddenly the waste tips started filling up with the first generation of fridges that nobody wanted *that worked*. And it was because the fridge-freezer had arrived on the scene.

Still sound mechanically, the working lives of these machines were being curtailed for reasons unconnected with their capacity to refrigerate. He sees this marking an important transition to a new phenomenon: the discarding of refrigerators, not because they did not work, but simply because they were outmoded and unwanted. This practice can prompt an uncomfortable clash of values. Many people support recycling and waste minimisation in principle, but still want new appliances. Mike said that people regularly call him up with appliances in good working order that they want to get rid of:

> I have to say I'm sorry I've no use for it and they feel very badly about it, and I feel very badly about it too because when I or they put that thing into the skip, the material that's in there is infinitely recyclable.

Increasingly, Britons are used to getting consumer products new, making it difficult to find a market for many secondhand goods. Rather than repairing or reusing them, the norm is now to regard consumer durables as 'disposable' and to throw them away, working or not.

> If I went down to 'the fridge graveyard,' and I went with my toolbox, I guarantee I could save half of the machinery down there, without spending more than £40 on each one. But what's happened with people is that they've become 'fashionised.'

While Mike talked hypothetically about rescuing machines from the 'graveyard,' this is precisely the basis on which a number organisations operate and I spent time with one such social enterprise called Respond, whose purpose involves rescuing items from the waste stream and diverting them back into use.

Responding to social needs: rescuing and adding value

Respond is based in the London Borough of Greenwich and serves a wide area across south London and Kent. In 1984, a Tenants' Association became aware of a high level of local need for basic items of furniture and set up a non-profit organisation, the Thamesmead Furniture Bank. A grant bought them a van and the group began collecting and redistributing donated furniture. In 1992 the organisation was renamed Respond. By this time it had expanded beyond Thamesmead and beyond furniture into electrical goods, clothing and a full array of housewares. Respond's remit is to help those members of the community most in need, such as refugees, asylum seekers, homeless people, women escaping domestic violence and people on low incomes, particularly the elderly, disabled and single-parent families. Respond contracts directly with local authorities and, on a typical day, social services will give the organisation the keys to an empty property in which they want to house a family. A team of staff and volunteers will clear the house, clean and paint it, lay carpets, fully furnish it and equip it with appliances and housewares, right down to the cutlery, crockery and curtains. With its warehouse ready-stocked with donated household goods, Respond can do this in just a few days and the people I spoke to took great pride in the fact that they can get a house set up and 'running' so rapidly for those in urgent need. Social services also directs recipients of Community Care grants and people on low incomes to Respond's warehouse to purchase affordable household items. Described by the volunteers as an 'Aladdin's Cave,' the warehouse stocks furniture, white goods, housewares and even books, toys and suitcases. Two thirds of Respond's clients are referred on from social services, housing associations and welfare agencies, but the warehouse is open to all members of the general public. As Henry, the organisation's Chairman, emphasised, "the people who can afford to pay help the people who can't."

Respond refurbishes a wide range of household electrical goods and there is "a constant demand for *essential household items* such as cookers, fridges, fridge freezers and washing machines" (Respond n.d., p. 5, my emphasis). Here, as discussed in the previous chapter, appliances like refrigerators are framed as integral to the constitution of domestic space and 'essential' to achieving a minimum acceptable standard of living. The message is that in contemporary Britain no one should be without a fridge. It is one of the necessities to which everyone should have access, including those in poverty. Part of Respond's role as a social enterprise stems from the premise that communities have a social responsibility to make affordable appliances available to all their members. For this reason, Respond set up a White Goods Workshop where appliances are refurbished and trainees learn repair skills. The organisation collects donations from around the region. People wanting to dispose of larger household goods will often call Respond rather than the Council, some primarily because they want these items to be put to good use, others simply because their collection times are so much faster. Goods do not have to be pristine, but they must be in reasonable condition. Respond has to be selective about what they accept and will turn down donations if they are too damaged, dirty or difficult to re-sell. Shaun Carter, Respond's Business Development Manager is very clear, "we are not here to provide rubbish to poor people, we're here to provide quality goods so that people in poverty settle better."

With six vans on the road full-time, Respond collects an average of twelve van loads of donated household goods per day, six days a week. I joined Rod and Jacko out on the van for one of their shifts and met them as they were pouring over an A-Z to map out the best route between the pickups they had been assigned. That day we collected an almost new Kelvinator fridge-freezer (Figures 6.3 & 6.4) and soon filled the rest of the van with a mattress, wardrobes and chests of drawers, children's toys and equipment and box loads of kitchenwares. I watched the two manoeuvre heavy and cumbersome pieces of furniture through narrow doorways and down flights of stairs. I listened as they gently turned down items they could not accept, the bed that was too damaged, the brand of washing machine too costly to repair, the style of couch that no one wants to buy, and gave advice on where to dispose of them. We arrived back at the warehouse where the items get sorted, cleaned, repaired, tested and set out for sale. There is a clearly gendered division of labour at the warehouse, one that closely parallels conventional domestic norms: men drive the pick-up vans and women cook the meals in the canteen; men lift the heavy furniture and women sort the kitchenwares; men do the carpentry and women sew soft furnishings; men fix the machines and women clean them.

Figure 6.3 & 6.4   Collecting and loading up a donated fridge

Source: own photographs

A training component is also integral to Respond's purpose. Shaun stressed that it was not just about carpets, couches or fridges going into homes, but about *cheap* carpets, couches and fridges going in homes *quickly*, by young people who've learnt a skill and are being employed to do it. Having outgrown its former premises, a move to a larger site in 2004 gave Respond the opportunity to open a dedicated Training Centre and bring in more trainees. In partnership with local colleges, youth programmes and employment services, Respond provides accredited training opportunities and work placements for young people and people experiencing long-term unemployment in areas of in electrical repair, furniture repair, carpet laying, warehousing and retail. Trainees also get access to career services and business start-up advice, helping them find work as professional tradespeople. In Shaun's mind, Respond's training programme is very much about "teaching a real trade that is dying out." By passing on the foundational skills of trades whose future is at some risk, Respond's work contributes to 'repairing' the business of repair by reviving the very diagnostic knowledges and practical repair skills that Mike suggested earlier were being lost. Respond's staff see a correlation between saving things and saving people from the 'scrap heap,' whether literal or metaphorical. Repairing objects and bringing them back into use gives them value. Respond also affords value to those who develop their own experience, skills and knowledge through working with these objects – those individuals' 'value' is enhanced by their participation in repairing objects, as are their employment prospects.

Repair, reliability and mobility

As to where Respond's fridges come from, some are donated, like the one we collected on my day out on the van, but most are retrieved from among those the council collects as waste. The additional workshop space and the ability to take on more trainees also have a knock-on environmental impact. It gives Respond the capacity to bring more marginal goods, things that were not previously viable to repair, out of the waste stream and into reuse. The number of items Respond collects and puts back into circulation has grown over the years from just over 1,000 in 1986, to 50,000 twenty years later. The organisation provides an important social need and the practice of reuse it facilities plays a valuable role in reducing waste. Henry stressed, "we're stopping thousands of tonnes, not hundreds, *thousands* of tonnes going to landfill every year." Those 50,000 bulky items that they sell are 50,000 things kept out of the waste stream. Shaun is angered that so many councils are guilty of "collecting perfectly useable machines, putting them on to lorries that don't have tailgates and, when they get to the transit station, pushing them off the back, thereby smashing them and turning a perfectly good, reusable piece of machinery, into landfill." By treating them as 'rubbish' rather than seeing them as something of potential value, such workers create unnecessary waste. Their actions raise a question about the point at which something becomes 'waste.' Things are rubbish because they are believed to be rubbish and they are treated like rubbish. If they are regarded differently, they have the potential to become something of value.

Rod and Jacko unloaded the fridge we collected that day and Doug wheeled it into the workshop area to assess (Figure. 6.5). In common with Mike's experience, mentioned earlier, Doug finds that about nine out of ten fridges he sees either need a new thermostat or a new relay. Fortunately, these are two of the cheapest parts to replace. When it comes to repair on a budget, brands matter. LEC and Hotpoint are the most common refrigerators that Respond deals with and the most affordable to repair. A new thermostat for these brands costs just a few pounds. Collection teams know to avoid bringing in Phillips and Whirlpool models because their replacement thermostats cost ten times the amount.

Figure 6.5 Wheeling a fridge into the workshop for testing

Source: own photograph

Most of the refrigerator repairs Doug carries out are not difficult but he clarified that although they replace components and perform mechanical repairs at Respond, they are not equipped to deal with refrigerants, so any refrigerator that leaks, requires topping up or has lost its gas, will not be repaired. Re-gassing is not a viable option for them.

> It's economics see, because of the price. We sell that [pointing to a fridge] for £40. For us to get a new part, de-gas, re-gas, whatever, is probably in the region of £80, so we can't do it, no matter how good it is otherwise.

Unfortunately, fridges rarely exhibit any outward signs to indicate whether they contain gas or not. Occasionally, there may be obvious punctures or evidence of damage, but usually one cannot tell by looking. Most leaks are not perceptible and only become apparent through temperature testing. Fridges that appear to be in good condition are brought into the workshop and left to run for twenty-four hours with a temperature gauge inside to determine whether they are capable of maintaining a sufficiently low temperature.

I watched Doug work as we spoke. The temperature gauge in the first fridge he checked indicated that it needed a new thermostat, which he fitted in a matter of minutes. Accessing a thermostat usually just involves just removing three screws, although manoeuvring his body in and out of the smaller cabinets can be awkward (Figure 6.6). After replacing a thermostat, he will always run a fridge for a further twenty-four hours to ensure that it can hold a temperature between 0-5°C. He replaced a broken shelf on the door with another from a fridge of the same make, then, cleaned and thoroughly checked, the fridge was ready for resale. Thus, with a £4 part, a small amount of his time, and his stock of cannibalised spares, Doug brought back into working order a fridge that had been on its way to be crushed. In fair condition, at an affordable price and with a three month guarantee, he had no doubt this would now be a fridge that someone would be very happy to have (Figure 6.7). Shaun makes a distinction between the appliances Respond sells and those from a second-hand dealer. Theirs are stripped apart, have the electrics checked and new parts fitted if required, so people are getting an appliance that he describes as 'next to new,' rather than 'second-hand,' for around one third of the price they would pay in a second-hand appliance store.

Figure 6.6   Doug replacing a thermostat

Figure 6.7   Fridges on sale in Respond's warehouse

Source: own photographs

The gauge in a fridge-freezer Doug left running overnight reads 7°C (Figure 6.8). This is too high for safe refrigeration. Doug suspected it would work with a new thermostat, but decided against repairing this one on the grounds that the freezer also needed a new thermostat, which was more expensive to replace. Judged uneconomic to repair, that one would join the machines returning to the waste stream. Those that Respond does not refurbish are taken back to the council for disposal, though not before Doug has stripped them for parts he can use in other machines. He keeps a stock of shelves, trays, lights and plugs and will often go round the council's waste transfer station with a 'shopping list' of parts he needs.

Figure 6.8 Checking the temperature gauge

Source: own photograph

Although many people might assume more sophisticated hi-tech appliances to be superior and more desirable, for Respond's purposes, the simple models are preferable because there is less to go wrong with them. Doug has tested fridges with electronic thermostats but finds they tend to have a lot of problems. Similarly, he comments that "frost-free, which are the newer models, we find are not very reliable. So we won't touch frost-free. … They don't travel well." To be of value to Respond and its clients, a refrigerator has to travel and must maintain its cooling ability as it moves. Doug points out that even new fridges that are well-packaged and handled gently have to be transported with care, positioned on a level surface and left to settle for a full two hours before switching them on. Respond's fridges have typically been carried up and down stairs, handled roughly, rescued from the waste stream and driven back and forth without packaging, "so you can imagine the problems we have. They've got to go to the dump, come here, get tested, get fixed, go away again. Refrigeration does not travel well," he emphasised again.

Of all the white goods they sell, Doug considers cookers to be the most reliable, then washing machines, and fridges the least: "we have more comebacks on fridges than other appliances," he told me, perhaps one in every twelve to fifteen. "I think it's basically the moving them about, because they all go wrong normally on the first day after they've been here a week." So, although the longevity of refrigerators compares very favourably to other appliances, as the *Which?* guide noted above, they tend to be reliable in situ but vulnerable on the move. The manner in which a fridge is moved is important. Doug stresses:

> they *must* be carried upright. … We do have people come and take them away and lie them down, and we tell them they're not going to have a guarantee. … Once they lay them flat I won't guarantee them as it does cause blockages and all the oil and the gas goes up the system.

Such handling indicates a lack of understanding on the part of purchasers as to how a refrigerator works. When Mike McFadyen discussed the operation of the compressor, he described it to me as a little four-stroke engine running in a bath of oil, "so it has to be upright, it has to be mounted the right way, because it's splashing oil." To operate correctly, the gases and the liquids must remain in their designated places in the cooling circuit, and if these get out of place, its operation is compromised.

Doug gets fifty to sixty fridges a week, of which he will get about half to work. The remainder go back to Greenwich Council. The council's vans drive past Respond's warehouse on the way to the waste transfer station and many of the drivers will stop off as they pass by to allow Respond's repair staff to pick off those fridges they think may be useable. In addition, the team will visit the transfer station to check for fridges that look promising. When Ian Staunton first became the Waste Manager at Greenwich Council in 1997, he described fridge disposal as a small service that largely looked after itself. Fridges were collected from households by the council, along with unwanted cookers, couches and the like, and brought to the municipal waste transfer station, or civic amenity site. There, the council removed the coolant and sent them through a multipurpose metal shredder along with other metal waste. However, in 2002, something changed. No longer a 'small' and straightforward service, fridge disposal unexpectedly swelled into an overwhelming problem and, with the onset of 2002, a peculiar sight emerged.

THE GREAT BRITISH FRIDGE FIASCO

An embarrassment of fridges

> Just 25 miles from the ivory towers of Cambridge University, a pile of 5,000 refrigerators, double stacked, gleams white in the springtime sun. Like sugar cubes spilled from a bowl, the fridges cover almost an acre of land (Happold 2002).

Had this been an isolated incident, a single sugar spill, it would not have provoked a national crisis, but this was a scene replayed around the country. Over 6,000 fridges were found in Knighton, Wales (Carey 2004). Bradford had accumulated 1,000 by February and was fearful this figure could swell to 10,000 by the end of the year (Telegraph & Argus 2002). Dorset County Council anxiously sought space for up to 20,000 and Hampshire County Council for 30,000 (BBC 2002). By 2003, East Sussex boasted 70,000 stacked in a pile forty feet high and a quarter of a mile long (Sapsted 2003), but the prize must go to Manchester, which, in 2004, still had 120,000 fridges amassed in mounds along the banks of the Manchester Ship Canal (Figure 6.9).

Figure 6.9 Fridge Mountain in Manchester

Figure 6.9 has been removed due to copyright restrictions. The image shows a dramatic aerial view of tens of thousands of refrigerators tipped in an ungainly heap in a field next to the Manchester Ship Canal.

The photograph was taken from the Manchester Evening News hot air balloon and can be seen on the Manchester Evening News website at: http://www.manchestereveningnews.co.uk/news/s/140/140973_work_begins_to_clear_fridge_mountain.html; and on the UK Whitegoods webpage at: http://ukwhitegoods.co.uk/modules.php?name=News&file=print&sid=1032

On January 1st 2002, British fridge disposal abruptly stopped. Article 16 of the European Commission Regulation 2037/2000 on substances depleting the ozone layer had come into force, bringing with it stringent rules for getting rid of old refrigerators. Henceforth, the only legal way to dispose of them was in specially licensed plants. The problem? When January 2002 arrived, no facilities existed anywhere in the country to meet these new standards and Britain was forced to play a rapid game of catch-up in the ensuing year to bring its processing technologies up to standard. In the meantime, the government was faced with the costly and cumbersome exercise of coping with the two to three million refrigerators thrown away each year, until such time as the means to properly dispose of them became available. Before long they were mounting up at waste sites across the country, "seemingly with no available route for appropriate disposal" (Williams 2003b, p. 11). Of course, for those individuals unduly eager to be rid of them, there are always routes of 'inappropriate' disposal, which is how thousands of fridges quietly found their way into fields and ditches under dark of night. Mr Partridge spotted first one, then two, and then, before long, fifty fridges dumped in a field on his farm in Cornwall (Booth 2002). Similar tales abounded from Dorset to Yorkshire and from Cumbria to Kent. And so, the 'sugar cubes' piled up. From a scattering here and a stockpile there was born a 'Fridge Mountain' that was neither sweet nor pretty.

That year, fridges showed up in all sorts of unexpected places. They filled fields, warehouses, media headlines and debating time in the Houses of Parliament. Bewildered by their sudden proliferation, Roger Williams (MP for Brecon and Radnorshire) spoke for many of his colleagues when he commented:

> When I was elected I was unprepared for the fact that so much of honourable Members' time was dedicated to talking about fridges – not even nice shiny new fridges, but dead fridges. Some of the exchanges at Question Time were a bit bizarre and surreal. … However, it is not just one dead fridge; we are talking about many thousands of dead fridges that are building up around the countryside (Hansard 2002).

Domestic appliances seldom become national talking points, and certainly not ones that are old, dirty, leaky or broken. To understand the origins of this crisis in Britain in 2002, we need to turn back to 1928 to visit a team of chemists at work in a laboratory in Dayton, Ohio.

Chlorofluorocarbons: from miracle to menace

During the 1920s, there were concerted efforts to find an alternative to toxic and potentially explosive refrigerants, such as ammonia, sulphur dioxide and methyl chloride. The breakthrough that would revolutionise the refrigeration industry occurred in the laboratories of General Motors' Frigidaire Division. It was here that Thomas Midgley, working with Albert Henne and Robert McNary, developed a new class of synthetic refrigerants known as chlorofluorocarbons (CFCs) (Midgley & Henne 1930). Patented in late 1928, CFCs were a remarkable development. Non-toxic, non-flammable, non-corrosive, odour-free and stable, they were hailed as 'miracle compounds.'

Midgely identified dichlorodifluoromethane (CCl_2F_2), which came to be known as CFC 12, as an ideal refrigerant and at the beginning of the 1930s the Kinetic Chemical Company, a joint venture between General Motors and DuPont, was manufacturing it under the trade name Freon. Initially, Freon was supplied exclusively for Frigidaire refrigerators, but soon a family of CFCs went into widespread use as refrigerants in refrigeration and air conditioning systems, as solvents in the electronics industry, as propellants in aerosols and as blowing agents for expanded foams, such as the rigid polyurethane foams used for insulation purposes.[69] A major application of trichlorofluoromethane (CCl_3F), or CFC 11, was the production of insulating foam for refrigerator cabinets. CFC 11 and 12 were the most common used chlorofluorocarbons and also the ones upon which domestic refrigeration became reliant. Indeed, Nagengast is among those convinced that domestic refrigeration could not have

69 Other forms of expanded foams include polystyrene, widely used for cups and fast-food trays, and urethane foams, the flexible foams found in carpeting and car seats.

become pervasive without the development of CFCs (Donaldson, Nagengast & Meckler 1994). In industry, refrigeration machinery was manually operated and supervised by skilled technicians and many doubted the wisdom of attempting to bring into the home a technology so heavily dependent upon dangerous substances. Embraced as completely 'safe,' CFCs were key to the domestication of refrigeration.

Four decades later, in a landmark paper published in *Nature* in 1974, Mario Molina and Sherwood Rowland made a connection between CFCs and ozone depletion and voiced a warning that CFC emissions could prove to be a source of great environmental harm (Molina & Rowland 1974). Ozone is a form of oxygen found mostly in the stratosphere, the region of the atmosphere lying between six and thirty miles above the earth's surface, where it forms a protective layer shielding the earth from ultraviolet (UV) solar radiation. While energy from the sun is crucial for almost all lifeforms, not all solar rays are beneficial. UV radiation can be hazardous to living things, but the ozone layer is a very effective mechanism for absorbing this radiation. Where this layer is thin or damaged, increased levels of harmful UV-B rays are able to reach the earth's surface (Herman *et al* 1996). In Molina's words, "the ozone layer is a very large natural system that provides an essential life-support function" (Molina 1997). The quality of chemical stability that rendered CFC compounds non-flammable and inert is the same quality that makes them take decades to degrade. Thus, as I explain below, the very thing that made these compounds so attractive as refrigerants turned out to be the basis of their eventual undoing.

Wandering molecules: the fridge, the sink and the stratosphere

The publication of Rowland and Molina's preliminary paper in 1974, and a more comprehensive version in 1975 (Rowland & Molina 1975), was met with a furious backlash from a chemical industry who claimed that speculations about the role of CFCs in ozone depletion, increased incidence of skin cancer and crop damage were irresponsible and unfounded. Nonetheless, twenty years later, the two would share the 1995 Nobel Prize for Chemistry in recognition of this work. Rowland mentioned in his Nobel lecture how his curiosity had been piqued by British scientist James Lovelock's surprise at discovering CFC 11 molecules throughout the air (Rowland 1995; Lovelock *et al*, 1973). Their presence had not previously been noticed because, for the first forty years of their use, CFC concentrations fell below the levels that instruments were capable of measuring. Only when Lovelock invented the Electron Capture Detector (ECD), a highly sensitive measuring device housing an electrode in a tiny chamber about two millilitres in volume, did it become possible to detect much smaller chemical traces (Lovelock 1974).

Lovelock first became aware of concentrations of CFC 11 when testing air samples around the cottage on the west coast of Ireland where he spent his summers. In a tale both irreducibly global and domestic, he tells the story of his "Travels with an Electron Capture Detector," the voyage from Britain to Antarctica that his wife agreed to fund from their housekeeping budget and the comparative CFC measurements he made around the world, using the ECD he constructed on the kitchen table (Lovelock 1997). His ECD readings indicated that CFC 11 was present in the atmosphere throughout the southern hemisphere (Lovelock *et al* 1973). The location of these molecules was a surprise, as was their ubiquity. They seemed out of place. There are no known natural sources for this compound and the levels Lovelock found were consistent with the total quantities that had been manufactured, meaning that little if any had decomposed (Rowland 1995; Lovelock *et al* 1973). For Rowland, this raised the question of what human-made molecules were doing here at all:

> Intrigued by the presence of a new component of the Earth's atmosphere, Mario Molina and I began investigating the eventual atmospheric fate of … these wandering CFC molecules (Rowland 1997).

Rowland and Molina concluded that CFCs released into the air gradually diffuse into the upper atmosphere. Most atmospheric pollutants are absorbed by sunlight, dissolved in water or oxidised in the troposphere, the lowest layer of the atmosphere, long before they have an opportunity to reach the stratosphere; however, being transparent, insoluble and unreactive, CFCs are immune to such processes of decomposition (Rowland 1997). This means that there are no 'sinks' for CFCs, that is, no mechanisms to break them down, in the lower atmosphere. CFCs are therefore able to survive for the decades it takes them to reach the stratosphere, whereupon they get exposed to shortwave radiation (UV-C) and decompose in just a matter of weeks (Rowland 1995). Within a couple of years, experiments confirmed Rowland and Molina's argument that the stratosphere was the sink for CFC emissions but, with stratospheric science itself “still in its infancy” at this time, it took the discipline rather longer to substantiate their theory about the role of CFCs in ozone depletion (Rowland 1995).

CFC production had accelerated in the 1950s due to the growth in domestic refrigeration and the development of other applications but, prior to the 1970s, there was little suspicion that their use might be harmful. CFCs escape from refrigerators and air conditioners, either through gradual leaks or when the coolant is topped up. Believed to be completely safe, these gases were also released into the air as a matter of routine from refrigeration systems or aerosol sprays. Even when the dangers had been recognised and waste operators were made responsible for recovering and destroying CFCs from domestic refrigeration units, there is evidence that some companies attempted to evade the costs associated with their safe destruction by simply sawing off the pipes and venting the gas into the air (ENDS 2001, p. 1). In the absence of tropospheric sinks, the molecules accumulated slowly but steadily in the upper atmosphere. Their presence, even in large quantities, might not have presented such a problem were it not for the chlorine they contained. As CFC molecules decompose chlorine atoms are released. When these come into contact with ozone, they create a reaction that destroys the ozone molecule but leaves the chlorine intact, free to repeat the same process, potentially thousands of times. Rowland suggests that a single chlorine atom has the capacity to destroy tens of thousands of ozone molecules. Thus, CFCs act as a vector to deliver chlorine directly into to the ozone layer (Rowland 1995, p. 277; Rowland 1997).

The circulation of scientific knowledges and the road to Montreal

The ozone layer had emerged as a political issue by the mid 1970s, although there was considerable disagreement about the cause of ozone depletion, the link with CFCs and the severity of the problem. Even Lovelock was not initially alarmed, doubting that the CFC levels discussed by Rowland and Molina represented a significant threat (Lovelock 1997). Several international organizations became involved, including the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), which organised the first international meeting to address the issue of ozone depletion in 1979 (Biswas 1979). Bans of CFC aerosol propellants in consumer products such as deodorants and hairsprays soon followed in the United States, Canada, Sweden and Norway, although refrigeration applications remained unaffected. Britain, evidently unwilling to relinquish its aerosols, was among those most resistant to CFC restrictions, claiming that the link with ozone depletion had yet to be made convincingly.

In the 1980s, developments in stratospheric chemistry, more extensive data collection and more sophisticated climate models all added to the weight of evidence pointing to a threat from CFCs and NASA was mandated to report to the United States Congress every two years with an analysis of the current state of knowledge of the upper atmosphere. By the mid 1980s, Robert Watson and his co-authors believed that evidence of the damaging effects of CFCs on the ozone layer had become compelling (Watson *et al* 1986, p. xi). Two reports published in the mid 1980s were to prove particularly influential. During 1985, WMO and NASA carried out a detailed assessment of threats to atmospheric ozone and, the following year, the US Environmental Protection Agency (EPA) and UNEP sponsored conferences and workshops about atmospheric ozone, CFCs and global climate change, before publishing the contributions from three hundred scientists and policymakers from twenty nations in a four-volume report (WMO 1986; Titus 1986). A risk assessment exercise conducted by the EPA soon afterwards concluded that increased concentrations of gases associated with ozone depletion presented unacceptable risks to human health and welfare (EPA 1987). These studies may have originated in the United States, but they were international in scope and represent a busy traffic in ideas between different nations. They also highlighted growing unanimity that the threat to the ozone layer was serious, that CFCs would have effects for decades, even centuries, and that any response would have to be a global one built upon international cooperation. The circulation of these reports did much to influence European policymakers. In light of the findings, and under pressure from their own environmental campaign groups, European states, including Britain, dropped their resistance to CFC production limits and acknowledged the need to take action (Morrisette 1989).

Perhaps most influential of all, though, was the discovery made by Joe Farman, Brian Gardiner and Jonathan Shanklin from the British Antarctic Survey (BAS) in 1985. They were the first to observe dramatic springtime losses in the ozone layer over Antarctica (Farman *et al* 1985). Taken aback by the enormous seasonal variation that their data revealed, they struggled to make sense of what they were seeing:

> The depletion grew so quickly that the researchers who recorded the data assumed at first that their equipment had malfunctioned. … All of a sudden we weren't talking about 5% over a century – we were now talking about 50%. I think it's hard for people not in the field to appreciate the shock value that the discovery really had on the entire community (Taubes 2002).

The shock was not restricted to this community of atmospheric chemists for Farman and his teammates' findings generated considerable attention in the media. The BAS team hypothesised that ozone losses could be due to increased CFC concentrations, just as Rowland and Molina had anticipated, but this could not be confirmed conclusively until further research was undertaken. Public awareness, closely coupled with anxiety, grew as the news circulated and "soon the world was talking about the 'ozone hole'" (Farman 1999).

Drake's account in *Progress in Physical Geography* (1995) indicates that, as well as uncovering a picture of a thinning ozone layer, the Antarctic data also revealed a much patchier grasp of the chemistry of the stratosphere than had hitherto been assumed. To gain a more comprehensive understanding, Watson coordinated a series of research expeditions to Antarctica. In 1986-7, Susan Solomon, of the US National Oceanic and Atmospheric Administration (NOAA), led two ground expeditions and NASA carried out an airborne data-gathering mission. Solomon explains in an interview with *Science Watch*:

> I got involved in the observational side of the issue because I strongly argued … that we ought to go to the Antarctic and make some measurements to figure out what's going on. It's one thing to see the ozone drop. It's another thing to measure the chemicals that actually influence ozone. … [So] I argued that we ought to have a ground-based expedition to Antarctica (Taubes 2002).

In her view, producing better knowledge required physically being in Antarctica to construct that knowledge from direct measurements, practical experiments and first-hand observations. Solomon's team concluded in a highly influential paper that the ozone hole was indeed caused by concentrations of human-made chlorine compounds, primarily CFCs, thus confirming the veracity of Molina and Rowland's 1974 hypothesis (Solomon *et al* 1986).

World CFC production did decline for a few years after the aerosol bans, but then steadily rose during the 1980s as use of refrigerants, foams and cleaning solvents expanded. Projections pointed towards continued growth in demand, particularly in the global South where countries like China and India aspire to a model of development that would see appliances such as refrigerators installed in every home. It was agreed that the only way to stem emissions was through joint initiatives to limit CFC use. The UNEP was instrumental in drafting the Vienna Convention for the Protection of the Ozone Layer in 1985 and, subsequently, the Montreal Protocol on Substances that Deplete the Ozone Layer. Ratified in 1987, the Montreal Protocol is an international treaty to protect the global environment (UNEP 1987; Benedick 1991). The Protocol is important for the measures it put in place to regulate the emission of ozone-depleting substances (ODS), key among these being CFCs from refrigeration equipment. It is also significant because it was based on theoretical rather than evidential scientific knowledge, that is, the Protocol, was negotiated on the basis of the *theory* that human-made chlorine compounds were depleting stratospheric ozone, rather than on clear and unequivocal evidence that they had already done so (Molina 1997), just as the Vienna Convention asserted that member states had a responsibility to protect "human health and the environment against adverse effects resulting *or likely to result from* human activities which modify *or are likely to modify* the ozone layer" (UNEP 1985, Article 2, my emphasis). The risks were judged sufficient to justify a worldwide CFC ban, the result being that the agreement was put in place and signed before full findings from the Antarctic expeditions or the satellite data became available.

The initial agreement reached in Montreal was to halve CFC production by the end of the century, but also to review the Protocol regularly in the light of new research. In 1988, the WMO/NASA Ozone Trends Panel reported the first evidence of ozone losses in the northern hemisphere, above North America, Europe and Japan (WMO 1988). The magnitude of the decrease came as a surprise. "Things are worse than we thought," Watson told a press conference following the release of the report (Andersen & Sarma 2002, p. 22). The findings showed that proposed restrictions would not be adequate, so it was agreed to strengthen the Protocol. At the London Accord in 1990, parties scheduled a total phase-out of CFCs by 2000 in all developed countries, and by 2010 in developing countries, until results of the 1991 Ozone Assessment prompted a further amendment in Copenhagen in 1992 (WMO 1992). Dates were brought forward once more; CFC production would cease in Europe by the end of 1994, in the rest of the developed world by the end of 1995 and in all other countries by the end of 2005.

The rapidity with which policy changes occurred was noteworthy. Molina and Rowland's hypothesis was published in 1974 and, despite considerable initial resistance from the chemical industry, in certain countries an aerosol ban was in place by 1978:

> It had taken less than five years to move from the scientific discovery of a potentially serious environmental problem to the implementation of a major new regulation designed to resolve that problem (Morrisette 1989).

Solomon notes a similarly seismic shift in accepted scientific orthodoxy:

> The possibility that the stratospheric ozone layer could be depleted by half at certain latitudes and seasons would have been deemed a preposterous and alarmist suggestion in the early 1980s. A decade later, the statement is acknowledged as proved beyond reasonable scientific doubt (Solomon 1990, p. 347).

With support at senior levels from key figures like Watson, described as the key person responsible for "marshal[ing] the scientific forces and resources" (Garfield 1992, p. 59), atmospheric scientists were able to mobilise quickly, gather data and work out what was happening in the relatively short period of a couple of years. Members of what Zerubavel (1997) would characterise as a 'thought community,' and what Haas (1992) terms a 'transnational epistemic community,' gathered and disseminated information to national governments and CFC manufacturers and helped guide policy with respect to CFC production and consumption. The emergence of a critical mass of influential scientists and policy makers in support of what were initially quite controversial theories enabled them to have some sway over the speed and stringency of the regulations. Scientific findings fed very quickly and directly into policy responses, diffusing rather more rapidly than the molecules in question. Garfield (1992, p. 59) argues that "the ozone story … is a tale that highlights the importance of scientific papers in the research process – how they often drive the regulatory and political process." The papers were deployed as carriers of diagnostic and repair knowledges, endeavouring to shape practices from the domestic to the global scale, in order to rectify the damage inflicted on the upper atmosphere.

And where are the refrigerators in all of this? As their owners went about their daily lives, confident that their milk would be kept chilled and their cold cuts kept safe, and as hundreds of scientists in dozens of countries organised on a grand scale to gather research teams, instruments, ships, planes, satellites and even the space shuttle, refrigerators in scrap yards and kitchens around the world, quietly and imperceptibly leaked refrigerant gases into the atmosphere. The hole in the ozone layer was the first major example of human behaviour being acknowledged to have affected the environment on a global scale.

In 1995, Ingmar Grenthe presented Rowland and Molina with the Nobel Prize for Chemistry. The comments Grenthe made in his award speech highlight the importance of the 'proper' place for certain chemicals. CFC emissions alter the composition of the atmosphere and the distribution of ozone, leading to a decrease in the stratosphere and an increase in the troposphere, where it becomes a contributory factor to global climate change.[70] As Grenthe (1997) points out, "whereas stratospheric ozone is a prerequisite for life, tropospheric ozone is strongly toxic and harmful to most organisms, even in small quantities." Ozone is important to human health, but only when it remains in the upper atmosphere and forms a robust ozone layer. Rowland and Molina's work was considered crucial to averting the unintended but potentially catastrophic consequences of apparently mundane human activities:

> CFC gases from refrigerators and air conditioners, and in the form of aerosol spray propellants – combined with a 'throwaway culture' – result in large-scale emissions of chlorine compounds into the atmosphere. The findings presented by the laureates in chemistry have had an enormous political and industrial impact. … One obvious result is … the Montreal Protocol, which regulates the manufacture and use of CFCs (Grenthe 1997).

Not unlike the challenges posed by germs discussed in Chapter 3, CFCs are difficult to see, to contain or to control. Most CFC emissions originated from urban areas the northern hemisphere, but, when the molecules escape, they are capable of travelling great distances and acting upon the environment elsewhere. The effect of these chemicals straying 'out of place' was first felt in Antarctica, far from the sources of contamination. The ozone hole was not, of course, caused exclusively by refrigerators, but it should not be forgotten that CFCs were brought into existence for the express purpose of facilitating the domestication of refrigeration. Despite the accolades Midgley received at the time of his invention, environmental historian John McNeill (2000) comments that "Midgley in my estimation is the single organism in the

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70 Reviews of fourteen years of satellite measurements of UV-B radiation at the earth's surface revealed a clear inverse relationship, that is, when ozone levels in the stratosphere declined, UV-B levels on the ground increased (Herman *et al* 1996).

history of the earth most consequential for the environment," due to his role in developing both CFCs and leaded gasoline (Ágoston, Millward & Sand 2001, p. 9).[71] CFCs' long-term effects were shown to be more far-reaching and long-lasting than anyone could have predicted. "A molecule that can outlast the pyramids of Egypt might be one to think about venting to the atmosphere especially carefully," commented Solomon in her *Science Watch* interview. "They may as well be immortal" (Taubes 2002). In this way, we witness 'small' things – like fridges, aerosol cans and chlorine molecules – having a disproportionately large effect, which helps us to think about the duration and the 'reach' of apparently 'ordinary' practices on an altogether different scale.

From this excursion to Antarctica and up into the stratosphere, I return to Britain to examine the effects of changing atmospheric knowledges and their expression in the signing of the Montreal Protocol. I discuss legislation arising from the Protocol in relation to the policy and practice of disposing of domestic refrigerators in order to examine why it was that fridges were landing in ungainly heaps upon the doorsteps of Britain's local authorities.

The making of a mountain

In Britain, the requirements of the Montreal Protocol were met through European Commission Regulation (EC) 2037/2000 on Substances that Deplete the Ozone Layer. European Regulations are more stringent and inflexible legal instruments than European Directives, which are incorporated into the national laws of each country individually. Regulations, on the other hand, have to be implemented as they stand across all European member states. As such, decisions made in Montreal and Brussels profoundly shaped the fate of Britain's fridges. The 'mountain' arose from two Articles of the Regulation in particular, or at least from Britain's response to them: Article 11 on the export of controlled substances, which came into effect in October 2000; and Article 16 on the recovery of controlled substances, which applied from January 2002. When January arrived, it became illegal to process domestic refrigerators except

71 The quote in Ágoston, Millward and Sand (2001) is taken from an interview with John McNeill discussing his book Something New Under the Sun (2000) on the public affairs program Dialogue, broadcast on US Public Radio International in January 2001.

in specially licensed plants. At the time, there were just two operating in the whole of Europe, one in Germany and one in the Netherlands.

Previously, whatever happened to a refrigerator after throwing it away remained largely invisible, at least from the perspective of the thrower. Once out of sight, said fridges could stay comfortably out of mind, until, that is, 2001 rolled into 2002 and first hundreds, then thousands, and eventually millions of dead refrigerators were thrust into hypervisibility in what proved to be a messy, embarrassing and very costly problem for the British government. Delays in tackling the crisis centred around the contested definition of two or three words so I discuss the semantic confusion from which the foundations of this mountain were unwittingly laid in the signing of the Regulation.

Creating a froth about foam

The polyurethane foam insulation in most refrigerators manufactured before 1996 used CFC 11 as a blowing agent. When the ozone-depleting effects of CFCs were discovered, it was recognised that both the coolant and the foam were a problem. Insulation foam actually contains more CFCs than the refrigerant gases and can account for up to two thirds of the ODS in a fridge, but early studies suggested that diffusion rates of CFC 11 from foam were very low (HoC EFRAC 2002, pt. 2). Legislation was therefore interpreted as requiring that CFCs be removed just from the cooling circuits before shredding. The benefits of trying to remove the foam were not considered sufficient to outweigh the costs. In April 1994, the year that CFCs were phased out in Europe under the Protocol, a joint Welsh Office and Scottish Office circular on waste management in the relation to the 1990 Environmental Protection Act stated:

> In the Department's view, at the time of issuing this guidance there are no operational processes in Britain which will recover the CFCs in foam at a cost proportionate to the environmental benefit achievable. For so long as the costs of recovering CFCs in foam remain disproportionately high it is not suggested that local authorities or others who receive discarded refrigerators need attempt to remove the CFCs from the foam before disposal (Welsh Office & Scottish Office 1994).

So, metal from refrigerator cabinets continued to be recovered and recycled, and other materials, including insulation foam, continued to be landfilled without treatment. However, when Kjeldsen and Jensen (2001) examined the handling and disposal of polyurethane foam, their measurements indicated that CFC 11 emissions from landfill sites were 100 to 10,000 times greater than the data in the literature predicted. Most CFCs are trapped within pockets of air inside the foam and these get freed as the foam is broken down. The quantities of CFCs released, and the speed at which they escape, depend upon way the foam is treated. The critical finding in Kjeldsen and Jensen's research was that emissions were much greater when the foam was cut into smaller sections, something overlooked in earlier studies which had only measured rates from large intact pieces of foam. Clearly, disposal by shredding dramatically increases the quantity of CFC 11 released into the atmosphere and the finer the foam is shredded, the faster the CFCs are released. The common practice of putting refrigerators through crushers with other metal waste – just as countless local authorities and waste management organisations routinely did – was discovered to be far more detrimental than had been assumed.

When the initial draft of the European Commission Regulation was circulated in September 1998, it had appeared unproblematic. It required that CFCs be recovered from refrigerant in the cooling coils, a straightforward process already being undertaken in Britain before cabinets were crushed. In November and December 1998, the Austrian Presidency proposed amendments to the Regulation, and it was the wording of this text that would later prompt uncertainty about whether the Regulation applied to the insulating foam as well as to the coolant. At the time, though, this ambiguity either passed unnoticed or was not considered significant and the draft Regulation was approved in Britain by the Select Committee on European Legislation. In January 1999, Britain first queried the issue of foam removal. The amendments to the text had made recovery of 'controlled substances' mandatory but the explicit reference to 'rigid foams' had been removed (HoC EFRAC 2002, pt. 19). Despite raising it a number of times, clarification on this question was not forthcoming. Nevertheless, the Regulation moved forward with agreement from all parties, including Britain, and was formally adopted by the European Parliament and the Council of the European Union in June 2000.

The legislation may have been in place, but Britain still did not have its answer. That would only come in June 2001, after a protracted correspondence between the Department for Environment, Food and Rural Affairs (DEFRA) and the European Commission. It seems that the government made repeated requests to the European Commission from early 1999, but only received the formal ruling that, yes, Regulation 2037/2000 did demand the removal of CFCs from insulation foam in domestic refrigerators six months before the legislation came into force. Unfortunately, the initial delay in clarification notwithstanding, the problem was compounded by a further five-month delay, this time unequivocally on the part of the government. Despite receiving the final ruling from the Commission in June 2001, there was a failure on DEFRA's part to inform the Environment Agency about the new requirements for foam extraction until mid November, just six weeks before the date of implementation. The Environment Agency is the body responsible for setting standards for recycling plants and for drawing up the rules within which local authorities and the waste industry would operate as of January 2002. If nothing else, there was serious miscommunication on the part of the government and a failure to make contingency plans. Many other member states had, like Britain, lacked the appropriate technology, yet all had evidently managed to take make alternative arrangements as none found themselves facing a 'fridge mountain.' Despite his protestations about the poor handling of the matter and the inexcusable delays, Jonathan Sayeed (Shadow Environment Spokesman and MP for Mid-Bedfordshire) commented that Members should have seen the problem coming nonetheless:

> We have known for many years that no other part of a refrigerator presents such a serious threat to the ozone layer as the CFCs in the insulation foam. … Because the aim of the EU regulation on fridge disposal is to safeguard against ozone-depleting substances, a requirement to extract CFCs from insulation form was inevitable (Hansard 2002).

It is the location of insulating foam, sandwiched as it is within the walls of refrigerator cabinets, that presents the challenge for CFC retrieval. The procedure requires specialist equipment with a sealed extraction chamber. With no such equipment available in Britain at the time, nor any plans in place to acquire any, it soon became painfully evident that the British government had signed up to a law with which it could not comply. Having establishing that the Regulation did apply to foam as well as to refrigerants, the issue then became one of arguing about *where*, and under what circumstances, it did so. This leads us into a tangled debate about a couple of small but crucial words upon whose interpretation the crux of the crisis hung.

The small print and the big 'if'

Michael Meacher, the then Environment Minister, argued that the confusion and delay arose around "whether the 'if practicable' part of Article 16 applied" (Hansard 2002). The question was whether the foam fell under Article 16(2) of the legislation, making the recovery of CFCs from foam "obligatory," or under 16(3), which would make it "obligatory if practicable" (European Commission 2000, my emphasis). This proved to be a big 'if', and one with major ramifications for the journeys of refrigerators in Britain, Europe and beyond. That 'if' would determine whether Britain's waste industry would be permitted to continue its current practice, or whether it would be obliged to invest in new processing technology, with a price tag of £2 million per machine.

Whether foam extraction was 'practicable' or not became, in essence, a spatial question, for it sought to determine whether the Regulation applied to foam insulation in all refrigerators throughout the European Union, or just to the foam insulation in fridges located in certain countries. It posed the question of whether the Regulation should be differentially applied according to the geographical borders within which those refrigerators resided, on the basis that removing foam was more practicable in some member states than in others. Government officials tried to argue that it was not practicable to recover CFCs from foam in Britain and that, consequently, the obligation to remove it did not apply. Malcolm Bruce, the Liberal Democrat Environment Spokesman, put it to the House that:

> The Government were relying on the words 'where practicable.' … The view in the United Kingdom … was that the technology was impossible and impracticable. Therefore, we could sign the directive because we could argue that what was proposed could not be done (Hansard 2002).

Unfortunately for Britain, Bruce commented, everyone else in that discussion knew that foam removal was practicable because the technology was being used in some member states already. "Those who drafted the directive knew that it could and would be done and were already doing it, or planning to do it" (Hansard 2002). In his evidence to the Select Committee, Peter Jones of Biffa Waste Services observed that while he usually found DEFRA officials to be genuinely committed to strategies for minimising emissions, in this instance he thought their motivation seemed at odds with the broader environmental principles:

> My perception is that … [UK officials] focussed on the fact that they were trying to work out how they were going to escape from what they saw as an onerous condition that they had agreed to" (HoC EFRAC 2002, pt. 26).

There were uncharitable suggestions that the government was laggardly in encouraging the waste disposal sector to set up plants because, as soon as the first plant became operational, CFC recovery from foam would then be 'practicable' in Britain, making the debate irrelevant and foam removal compulsory. If stalling had been a deliberate ploy, it was not, in the end, a successful one. The big 'if' of clause 16(3) proved too small for the government to hide behind. The European Commission determined that the wording in Article 16 referred whether the process was technically possible, rather than whether it was currently practicable in Britain. Those national borders held little sway. Being practicable elsewhere in Europe meant it was deemed practicable in Britain too. With six months to go before Article 16 became law, no progress on setting up recycling plants and nothing much resembling a 'Plan B,' the stage was set for fridges to became a major problem.

The origins of the 'fridge mountain' crisis were fiercely contested and bitter rows ensued about where and with whom to place the blame. As Law points out, explanatory stories about the failure of a system frequently turn into a search for where responsibility lies (2000, p. 2). The way Bill Wiggin (MP for Leominster) saw it was that, having approved of a worthy principle, the government signed the Regulation without much thought to its consequences. Once the full impact was realised, "they played for time, lost, and had an environmental crisis on their hands. Since then, they have been looking for someone else to blame" (Hansard 2002). Meacher strenuously claimed that when the Regulation was passed:

> No one – not the Presidency, the Commission, or any Department in any member state … [or] the waste management industry in the UK and elsewhere, asked whether it also applied to insulation foam.

He argued that the changes giving rise to the ambiguity were made by officials in Brussels, so were not the fault of the British government, and claimed the government was left unprepared by lengthy delays on the part of the Commission about how the Regulation should be interpreted. Bruce put it to Meacher that the British government was made aware of its obligations in October 2000 and that any delay thereafter was caused by the government raising technical objections (Hansard 2002; Clover & Evans-Pritchard 2002). Meacher protested that his civil servants made repeated requests to the Commission for clarification, requests that officials failed to answer on nine occasions. In January 2002 he described the government as having been badly let down by the Commission who, in his view, was to blame "for failing for two and half years, until June 2001, to provide a formal ruling as to whether the gases used to blow the foam in fridge walls would have to be recycled too." Environment Commissioner Margot Wallström took issue with Meacher's version of events, adamant that responsibility for the crisis be laid firmly at the British government's feet. She accused Meacher of misleading the House of Commons and misrepresenting the European Commission by blaming Brussels, pointing out that since October 2000 a British representative had attended regular meetings in Brussels to prepare for the new rules and had been kept informed at every stage in the development of the Regulation.

In the aftermath of the fridge fiasco, the Select Committee on Environment, Food and Rural Affairs undertook an inquiry. With fridges metaphorically exploding in his face, Meacher was summoned before the Committee for questioning. The Select Committee was critical of the speed with which the legislation was rushed through. It seems the Austrian President was pushing for a quick resolution and the Committee found it unsurprising that after scheduling only three or four weeks for consultation with stakeholders certain aspects of the Regulation were overlooked or misunderstood (HoC EFRAC 2002, pt. 16). Although the Committee did find failings on the part of the Commission, it judged the primary fault to lie with the British Government for having signed up to a Regulation without first ensuring it was cognisant of the implications and also for having failed to put in place any contingency plans. Committee members believed that the outcome of the deliberations should have come as no surprise to British officials. "Given that they had received legal advice early in 2000 which indicated that Article 16(2) of the Regulation could be interpreted as requiring recycling of CFC bearing foam, it is unfortunate that for whatever reason officials chose not to take the advice given" (HoC EFRAC 2002, pt. 41). Instead, it seemed as though the government took a gamble on semantics in the hope that the worrisome prospect of looming stacks of all-too-material fridges might simply be argued away.

Re-routing the flows of dead fridges

So long as questions remained unanswered about what was practicable where, the issue of who was going to take responsibility for refrigerator processing and, more to the point, who was going to foot the bill, remained equally opaque. Ultimately, as the Local Government Association explained to the Select Committee, it was local councils who were hit hardest by the making of this mountain:

> Local authorities are having to bear the brunt of a problem outside their own making. … In the United Kingdom the financial and organisational buck has stopped with the only bodies who have any legal obligation to dispose of fridges: local authorities (HoC EFRAC 2002, pt. 38).

An additional twist came in the shape of Article 11. The scale of the disposal problem facing local authorities was compounded further by interruptions in the flow of discarded refrigerators to other destinations. Prior to 2002, major white goods retailers had removed customers' old appliances free of charge when they delivered new ones and passed them on to waste companies for disposal. About half of Britain's unwanted fridges were collected by retailers, and the rest by local councils. However, with regulations immanent and the availability of processing facilities uncertain, retailers discontinued their 'take-back' schemes in November 2001 for fear of being burdened with disposal costs. Customers were referred to their local councils instead. The effect was that all the fridges formerly collected by retailers were diverted into local authorities' hands, vastly increasing the number they had to deal with. Greenwich Council, for instance, collected around 3,500 domestic fridges in 2001. In 2002 the figure was closer to 6,500. No longer permitted to shred these itself, or to sell the metal on for scrap, Greenwich suddenly found itself faced with double the number of fridges and a fee to pay in order to dispose of every single one. It was a pattern repeated around the country, though its ramifications reached much further.

The economics and ethics of export

Writing in *The Telegraph* in November 2001, columnist Christopher Booker foretold of a "bizarre disaster" promising to unfold with the implementation of regulation 2037/2000, "the results of which," he warned, "will not only soon be evident along Britain's roadsides but will cause problems for millions of people in the Third World" (Booker 2001). Sure enough, the consequences of changing the rules about where dead fridges were and were not allowed to go was seen throughout Britain in the shape of council stockpiles and illegal dumping, but was also felt well beyond the borders of the European Regulation signatory states and even into parts of Africa. In addition to the suspension of the take-back schemes, a second contributing factor affecting local councils was the abrupt cessation of what had been a flourishing export of used refrigerators to West Africa and Eastern Europe. Before the Regulation, up to 40% of unwanted refrigerators were refurbished for reuse. However, the way that Article 11 was drafted prohibited the export of CFCs, or any "products or equipment" containing ODS, outside the European Union. For a time, semantic uncertainty surrounded the issue of whether 'foam' counted as a 'product.' The minutes of a planning meeting on 4th October 2000 show that committee members reached agreement during the meeting that, for the purposes of the Regulation, foam would be classified as a product. We see here a very literal instance of meaning-making in action. The definition of 'foam' was not fixed *a priori* but decided by consensus on that particular day. The instability of language always leaves open the possibility of varying interpretations of words because meaning is relational, not absolute. As Saussure (1974) shows us, the sign is an arbitrary relation between signifier and signified. As such, its meaning could potentially have been otherwise. For now, though, the matter was settled. Foam was a product and the Regulation put a stop to its export beyond the European Union, meaning that even in cases where refrigerants had been replaced with non-ODS substances, refrigerators could not be exported if CFC-blown foam remained.

Now officially classified as products containing 'controlled substances,' fridges had moved category. This conceptual shift was accompanied by strict policing of their physical movements. When Article 11 came into force in October 2000, Customs and Excise duly prevented refrigerators leaving the country for any destination outside the European Union. Fridges promptly started piling up at British ports. Only then did the scale of the export trade become apparent. The value of this trade was estimated at around £30 million per year, yet its very existence was little known, even within the government (HoC EFRAC 2002, pt. 33):

> DEFRA, the lead government department responsible for implementing the regulation, was unaware of the existence of the sizeable export market for used fridges in West Africa. It seems that the Customs and Excise Department neglected to inform them of the 1-1.5 million fridges sold in this way annually (Williams 2003b, p. 16).

Despite the supposed involvement of Customs and Excise in planning meetings, at a meeting in late October 2000, DEFRA and the Department of Trade and Industry (DTI) both confessed to having had no knowledge of the trade before it was abruptly curtailed earlier that month (HoC EFRAC 2002, pt. 23). The Select Committee found it surprising that although exporters had been warned about the loss of this substantial export business, other government departments remained completely unaware. Meacher likewise conceded: "I am as astonished as you are that when 40% of fridges were exported that this was not known to Government Departments" (HoC EFRAC 2002, pt. 33). For most people, the trade became evident only in its absence, at which point the material effects of the Regulation made it highly visible. At the government's request, Customs and Excise suspended the ban and permitted exports until January 2002.

Fred Probert's firm, Border Refrigeration & Domestics, based near Abergavenny in South Wales, was one of the small companies that had for many years refurbished fridges and freezers from the take-back schemes and exported them to African and Eastern European countries. Britain's used refrigerators were particularly sought after in Nigeria. Low wages and high import duties made purchasing a new fridge impossible for most of the population. As both countries operate on a 240v electricity network, Britain was one of the few places from which Nigeria could import compatible second-hand machines. Such fridges undertook journeys far more arduous than those Doug had despaired of, up and down flights of stairs, in and out of vans and to and from his workshop at Respond. These ones arrived in Nigeria by container ship and travelled on in ways unimaginable in Britain:

> At a port near Lagos Mr Probert recently saw his machines being carried on the heads of teenage boys to be loaded on to battered Volkswagen pick-up trucks and transported all over Nigeria (Booker 2001).

Some would be used in homes, others to store drugs and vaccines in medical clinics, often in remote locations hundreds of miles from urban centres. Doug was one of the few people I spoke with who had been well aware of the second-hand trade in fridges from Britain to East

African countries. While showing me some of the fridges he had recently repaired, he commented:

> They used to export these to Africa, but now that's been stopped. I know someone who used to send over two or three container loads a week. It was big business. The Africans were sending them over by the boatload, thousands and thousands a week. … Most of these I reckon would probably have ended up in Africa.

With this second-hand trade now illegal, most exports stopped, though Doug said he had heard of people "taking their chances" and still sending fridges over; "but they're coming down hard," he added, referring to people getting caught and fined. The main difference he had noticed following the Regulation was the increase in the number of refrigerators being offered to Respond, "so in fact it's probably helped us. We're probably the only ones it has helped" he laughed.

The Regulation had a serious impact on businesses refurbishing fridges from the take-back schemes. For many of the smaller waste management contractors, this represented their most profitable activity and the implementation of the Regulation saw some of them squeezed out of business. In December 2001, "owner Fred Probert told the *Argus* … that his business was under threat from the legislation. He had already laid off three of his nine staff as a result. His company exports unwanted fridges to the Third World, but … the EU rules put this at threat" (South Wales Argus 2001). While the effect of Regulation was successful in terms of limiting ODS emissions, there was a price to pay, both by those who lost jobs in certain sectors of the waste industry and by taxpayers; Williams argues that "when understood in the context of sustainable development it can be seen that greater environmental sustainability was achieved at the expense of social and economic sustainability" (2003a, p. 2).

The end of the export trade was an unintended effect of the legislation. Once its impact was realised, there were lengthy debates about the rights and wrongs of exporting used refrigerators to countries in the global South. Both those supporting and those opposing the continuation of this trade drew on narratives of saving lives and minimising risks to human health. Many felt strongly about the loss of the only source of affordable refrigeration for many people in these countries, and also the loss of a valuable outlet for refrigerators that were still in working order. Sayeed said of the exports:

> Most went to the poorest countries in the world which cannot afford new refrigerators in which to store essential drugs. However, the Government have now admitted that until Customs and Excise began to enforce the regulation … [they] did not realise that the regulations would destroy that life-saving trade (Hansard 2002).

The broader question becomes one of whose lives are being saved, where, when and by what means, embedded within which is an implicit trade-off between different space-times and different kinds of risk (Douglas 1992; Beck 1992). On one hand, the absence of refrigeration is framed as dangerous because it compromises the safe storage of foods and drugs. In a letter from DEFRA to the European Commission exploring the possibility of finding a resolution by rewording Article 11, the department emphasised that "there are economic, humanitarian and environmental reasons to encourage this trade in fridges," so long as CFC refrigerants are replaced by more environmentally friendly refrigerants, for "the alternative is no refrigeration, with implications for the preservation of both food and medicine" (DEFRA 2001). On the other hand, the very presence of these refrigerators is regarded as a danger because the sticky issue of the insulating foam remains. The fridges represent a threat to the environment because of the potentially harmful substances from which they were constructed. It would seem, therefore, that there are also economic, humanitarian and environmental reasons to *dis*courage this trade in fridges. In a complex trade-off between social and environmental benefits, the rationale for the former viewpoint is that continuation of the trade protects lives currently being lived and reduces waste by promoting practices of reuse, whereas the latter position is that stopping the trade minimises environmental harm so as to protect potential future lives.

Ultimately, the export ended, rightly so in Meacher's view, and in they eyes of many environmentalists who believed that, however compelling the humanitarian arguments, the decision had to be governed by an overriding objective to minimise ODS emissions. Continuation of the trade would not reduce emissions but simply shift them somewhere else. Its effect would be to perpetuate the very damage that the legislation was intended to curb if destination countries did not have disposal facilities capable of capturing ODS when those machines eventually came to the end of their working lives. Prior to the regulations, "a fridge destroyed in the UK, Germany or Finland would harm the ozone layer in just the same way as the same fridge scrapped after fifteen years of further useful life in Ghana, Nigeria or Burkina Faso" (DEFRA 2001, p. 2). That being so, principles of sustainable development would support these fridges continuing to have useful lives elsewhere on the basis that the overall impact would be the same and the interim benefit much greater. However, another argument is that this kind of trade provides a way for wealthier nations in the global North to 'export' not just their unwanted goods but also their environmental responsibilities. Rather than meeting the cost of retrieving and destroying CFCs themselves, responsibility for their future impact is offloaded onto to destination countries in the South. Once the European Commission Regulation took effect, disposal became a more place-specific practice, with those refrigerators used in Europe and discarded in Europe now having to be disposed of in Europe.

From household good to hazardous waste

To explore how local authorities and the waste management industry coped with the task of collecting, storing and disposing of Britain's two to three million redundant refrigerators in the aftermath of the Regulation once shredding was no longer an option, I visited Greenwich Council's waste transfer station in southeast London and EMR (European Metal Recycling) in north London to learn more how disposal practices had changed. Ian Staunton, Greenwich Council's Waste Manager, emphasised how much local councils' handling of fridges altered once the Regulation came into force and how fridges had expanded into a much more significant component of his own job. Greenwich Council was no longer permitted to shred fridges on site itself. Instead, the authority was obliged to outsource disposal to companies equipped to process the cabinets in an airtight chamber. Rather than generating a modest income from their scrap value (about £1 for every half a dozen, according to Environmental Data Services (ENDS) estimates), fridges became a huge financial burden because Councils now had to pay between £20 and £35 to dispose of every one (ENDS 2001, p.1). As Ian and I talked on site, Respond were checking over some the fridges collected that day and selected six to take away for testing. This was good news for Ian; those six would save him about £120 in disposal costs. These costs arrived as a rather nasty new year shock for which local authorities were completely unprepared. They had only been notified about the new procedures a matter of weeks before the Regulation came into effect, which gave them no opportunity to budget for this expenditure and left them to find the funds from already overstretched public service budgets until the Treasury came up with what many regarded as a rather meagre financial assistance package.[72]

Local authorities' statutory responsibilities include collecting household refuse on a weekly basis without charge. Authorities are also obliged to carry out additional collection rounds for garden waste and 'bulky household items,' though they are permitted to charge for these services to cover collection costs.[73] While a few authorities do charge for fridge collection, most, including Greenwich, choose not to, for fear it would encourage illegal dumping. When people call the Council to collect a fridge, Ian's team will schedule a pick-up and send round a van. Up until December 31st 2001, fridges could be carried along with all the ovens, couches, mattresses and other large unwanted items. The arrival of January 1st 2002 brought with it logistical complications for domestic refrigerators were no longer 'bulky household items.' That day, they turned into 'hazardous waste.' Now classified as 'Ecotoxic,' one of the fourteen hazardous waste codes in the European Waste Catalogue (EWC), more stringent rules applied to their transportation and disposal. Legally, fridges could no longer be carried alongside other household items but had to be transported separately, necessitating an additional collection round. The change in status of these discarded refrigerators also generated an increase in the paperwork associated with every fridge. Hazardous waste regulations require that 'consignment notes' are completed before any such material can be moved. These detail the quantity of waste, its EWC codes, where the material was removed from, where it was taken to, by whom, when it was delivered and how the waste was treated. Consignors, consignees and carriers have a legal duty to keep these records for a minimum of three years so from the start of 2002 the movement of dead fridges produced an audit trail, a new kind of material mapping of their journeys.

72 In December 2001, DEFRA announced that £6 million would be made available to help local authorities with storage costs until the end of the financial year. With close to 500 local authorities across England and Wales, this amount was thinly spread. Angela Watkinson (MP for Upminster) reported that Essex County Council's predicted share of the £6 million was likely to be only £50,000 and yet the council estimated that its costs would climb to over £1.5 million (Hansard 2002). By April, Meacher acknowledged that the cost of processing the backlog could be as much as £40 million; others predicted much more.

73 People transporting their own fridges and freezers can drop them off at civic amenity sites free of charge.

Given that no facilities for processing fridges were available at the start of the year, early 2002 was perhaps better characterised by the *lack* of mobility of said refrigerators or, at best, their somewhat truncated journeys into interim storage spaces. Local authorities had little option but to set up storage sites across the country to stockpile fridges. Environment Agency guidelines required that refrigerant gases be removed and cabinets be stored upright to prevent leakage of CFC refrigerants and oil. Units could not be stacked more than two high for health and safety reasons and to minimise the risk of damage to the cabinets before processing. Nevertheless, there were numerous cases of companies assuming they could pile them high and simply fill up fields and warehouses, as in the aforementioned case of a stack in East Sussex forty feet in height and the mounds in Manchester. The processing backlog and the lack of space in which to keep these discarded refrigerators created opportunities for entrepreneurship that few could have foreseen before the crisis. Business boomed providing space to store dead fridges for a fee. Companies were able to apply to the Environment Agency for a Waste Management Licence and could then contract to collect and store refrigerators. Holding spaces sprang up around the country, a kind of fridge 'death row' where these appliances languished awaiting their end.

It was not until the second half of 2002 that processing plants came on stream in Britain. Greenwich was in a more fortunate position than many councils because it operated a waste transfer station with space for storage. Some councils, unable or unwilling to stockpile fridges in large quantities, made the decision to export theirs to other signatory states with operational plants and spare capacity. So long as these fridges remained within the European Union and were shipped to countries with appropriate facilities, this was a legal practice, even if not one entirely congruent with transport economics or principles of sustainability. By the end of 2002, an estimated 299,000 fridges had been processed in England and Wales. A further 418,000, 58% of that year's total, were exported to Germany and the Netherlands for disposal. Capacity in Britain had expanded significantly by 2003 but, despite disposing of nearly a million fridges that year, of which just under 40%, were exported, a considerable backlog remained (ESA 2004). In early discussions, Andrew Mason of EMR argued that a large number of processing plants would need to be distributed across Britain to minimise travel distances because the cost of transporting unflattened appliances was so great (ENDS 2001). Fridges – especially dead ones – are not high value goods, but they are fairly bulky objects that take up a lot of space. Obviously, the whole point of the new legislation is to prevent them being broken up before they reach specialised treatment facilities. Transport costs are therefore high relative to the value of the cargo. Akin to moving empty boxes, consignors are, in effect, paying to transport a lot of 'air' around the country, or even across national borders.

In March 2002, Greenwich Council signed a contract with a fridge disposal company located about 150 miles away in the Midlands, rather than the processing plant due to open in north London, about 25 miles away. Although this would obviously have been much closer than the Midlands plant, the disadvantage was that the company was looking for a five year commitment from local authorities. The Council would have been locked in to a price per unit for the duration of the contract and would have stood less chance of renegotiating the cost per unit down by half, as they were with their current contractor. It was therefore judged to be the best solution in a difficult situation and, once the plant became operational, Greenwich started sending 600-800 fridges a month to be processed. Ian recognised that the decision to drive thousands of fridges a year across the country from southeast London to the Midlands did not fit with the proximity principle to which the Council subscribes, the principle being that waste should be treated as close as possible to where it was generated. In addition to the risks associated with moving hazardous waste, transportation also brings its own economic and environmental costs. The traffic in redundant refrigerators, whether cross-country or internationally, offers an uncomfortable choice between trying to reduce ozone-depleting emissions and running the risk of raising greenhouse gas emissions by burning fossil fuels.

Feeding the 'fridge eaters': a cyclone in a box

To tackle the fridge mountain, Britain's waste industry had to invest in "sophisticated 'munching' machinery that can tear fridges apart in sealed conditions to capture the CFCs from the foam" (Booth 2002). In the spring of 2002, a German company began operating a mobile fridge-recycling plant in the south of England. By the end of the year, two mobile plants were running and eight static plants had opened, with more underway. The two companies dominating Britain's scrap metal recovery industry are EMR and Sims. Both took a lead in fridge recycling and invested in specialised equipment from MeWa Anlagen, a German firm with nearly three quarters of the market share of refrigerator recycling machinery in Britain (McCann 2002). Sims in Newport, South Wales, was the first of the new generation of so-called 'fridge eating' plants to become operational in Britain. It went on stream in July 2002, followed two months later by EMR's fridge facility at its scrap metal plant in Willesden, London (Figure 6.10). This is where the Templetons' fridge would have ended up and I visited EMR to trace the final stages of its journey. Carl Aspin, Manager of EMR's Fridge Recycling operation, showed me around the site and talked me through the process.

Figure 6.10 EMR's Fridge Recycling facility in Willesden, London

Source: own photograph

The fridge plant operates twenty-four hours a day, seven days a week. Every weekday, half a dozen large trucks and seven or eight smaller vans deliver between 1300 and 1700 fridges (Figure 6.11). The machinery eats through 1000-1300 units per day, but Carl wants 2500-3000 stockpiled by the end of the week to see him through the weekend. By Monday the yard is pretty much empty again. These fridges come from all over the country. As well as having contracts with eleven London Boroughs, Willesden also receives fridges from places including Leeds, Hartlepool, Norwich and the Isle of Wight. In addition to local authorities, EMR has contracts with retailers like Comet, some of whom have resumed their take-back schemes, though this time for a fee. Members of the public can turn up at the site to dispose of a single fridge, though this is rare. The company also works with Ozone Friends, an organisation which, much like Respond, refurbishes fridges for community use.

Figure 6.11 Fridges being delivered and awaiting disposal

Source: own photograph

After being stripped of its shelves and drawers in the loading bay, the Templeton's fridge would have joined the other cabinets on a conveyor belt. First, the power cable is cut off each fridge and a device clamped onto the pipe leading to the compressor. A needle pierces the pipe and siphons off the liquid coolant and the oil. These fluids will be heated to separate the CFCs from the oil, which is pumped into bottles and returned to BOC Gases for reuse. The compressor is then removed from the back of the fridge by cutting through the metal band securing it in place. Some compressors are put through a shredder along with general metal waste, others are sold overseas, refilled and put back into use. Next comes the 'carcass processing.' Cabinets are carried up a steep conveyor belt, through a series of three airlocks and fed, five to ten at a time, into the 'QZ' machine or 'fragmentiser,' at the heart of the plant (Figure 6.12). Short for the German term, *Universal-Querstromzerspaner*, this translates roughly as 'Cyclone Chamber.' Appropriately named, this is a steel chamber with walls about ten inches thick in which the cabinets are broken up by the massive forces generated by a set of six-foot chains spinning at speeds of up to 6,000 rpm. Pulverised against a spiked structure at the base of the chamber, the fridges disintegrate into their various component materials.

Figure 6.12 On route to the sealed 'cyclone chamber' to be broken down

Source: own photograph

Atmospheric conditions are carefully controlled inside the QZ chamber. During processing, nitrogen is injected to keep oxygen levels low so as to minimise the risk of explosion while cabinets are broken down. As the insulating foam is ground into dust, CFCs are released and forced out of the chamber under high pressure. This gas is captured in a recovery unit where liquid nitrogen creates a sufficiently low temperature to condense the CFCs into a liquid form. Canisters of CFCs are then sent away to be destroyed by high temperature incineration. The chains used in the chamber are durable enough to shred 1100-1200 fridges so, given the numbers processed at the plant, they are replaced nearly every day, although before anyone can enter the chamber to change the chains, oxygen levels must be raised back up to a safe level.

The QZ has the capacity to process 60-100 refrigerators per hour, so within ten minutes the Templeton's fridge, along with half a dozen others, would have been reduced to shards and dust. With the CFCs safely extracted, the shredded material leaves the QZ on a belt and goes through a series of steps to divide it into four product streams: ferrous metal, not-ferrous metal (primarily aluminium, but also small amounts of copper), plastic and polyurethane foam dust. The dust is sieved out, fragments of iron and steel are removed by electromagnets positioned over the belt and plastic granules are separated from aluminium using eddy currents to sort them by their different electric conductivities. Most of the materials in a fridge are recyclable. The metals fragments, aluminium and plastic granules are collected and sold on to specialist recyclers for reuse. Just the powdered polyurethane dust remains, which is sent for landfill. Britain's scrap metal industry is well established and the scrap from these fridges becomes an internationally traded commodity. Like all EMR's sites, the Willesden plant was constructed with a rail connection and much of the reclaimed metal is shipped overseas from the company's deep sea berths at Tilbury, on the Essex coast. Once broken down into their constituent parts, dead fridges cease to be 'waste' and are reborn as raw materials. Their journeys as refrigerators may have come to an end – reduced, like the Templeton's fridge, to four small piles of granulated steel, aluminium, plastic and dust – but materials travel on to be remade as other products in other places, each of which will then embark on a new lifecycle and new journeys of its own. The final section of this chapter brings me to a rare refrigerator that undertook a lengthy journey but escaped the path of disposal and destruction to end up preserved in a museum.

THE MOVE TO THE MUSEUM: FROM EVERYDAY APPLIANCE TO HISTORIC ARTIFACT

Of all the fridges I encountered in my research, a 1966 RCA Whirlpool fridge-freezer was the most widely travelled. It was formerly owned by Fred and Marianne Emery and is now part of the Science Museum's domestic technology collection. For many years Fred was a correspondent for *The Times* but became best known as a presenter on the BBC current affairs programme *Panorama*. His refrigerator is noteworthy for having made a remarkable journey of some 23,000 miles during the course of its working life. I trace some of the physical and conceptual journeys that this fridge undertook as it travelled around the world and then made the transition from a household appliance to a museum artefact and from a technology of 'climate control' to an object that was itself preserved in climate controlled conditions.

The well-travelled Whirlpool

The Emerys purchased the refrigerator in 1967 while living in Tokyo, where Fred had been posted as a foreign correspondent for *The Times*. American friends who lived nearby helped Fred and Marianne buy American appliances at low cost through the US military base where they worked. These friends bought a washing machine and a dryer on their behalf:

> Then they said you ought to have a fridge too. Come on, we'll get you one. So in early '67 we bought this fridge through the PX at Camp Zama.[74] They even delivered it. So there was this amazing monster, with a fridge at the top and a freezer at the bottom. It was probably about the same price you'd pay for a tiny little Japanese fridge, so we thought it was *fantastic*.

In the 1960s, Japan's manufacturing sector was not yet well developed and American appliances were much higher quality than those available locally, as well as substantially larger. It was only a few months after the fridge arrived that Fred was posted to Singapore. *The Times* covered the cost of shipping its correspondents' household contents so along with the Emerys went their fridge, washing machine and dryer. Marianne described how glad she was to have a fridge while living in Singapore, partly due to the tropical climate, but also because "it was this big colonial house, 'ants galore' everywhere, and the fridge was wonderful because that was ant-free. It was the only ant-free thing in the kitchen," she laughed. Ants have a knack of finding their way into virtually any space, but in Singapore the Emerys' fridge became a good exemplar of arguments put forward in the early fridge-promotion literature that a refrigerator protects food from exposure to flies and other insects. It created a safe space, separated and enclosed.

The presence of this large American refrigerator also served to highlight certain cultural and infrastructural differences. Not long independent, Singapore was still very English-oriented and the fridges used there tended to be small English-style ones. "Nobody had really seen big fridges before in Singapore in '67," Fred commented. Theirs became a palpable marker of difference and an object of considerable curiosity and comment among their colleagues, friends and neighbours. In Japan, their 110v American fridge had been able to run directly from the mains, but this was not possible in Singapore's because the voltage was different.

74 A 'PX' is a 'postal exchange,' or post office, located on each base.

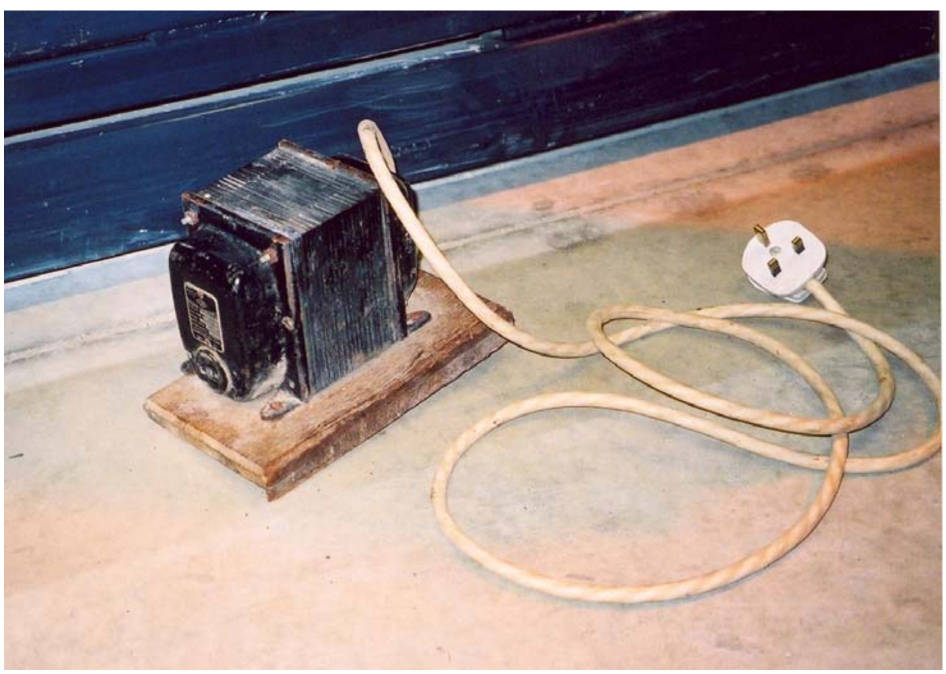
Fred bought a transformer, mounted it on a piece of wood and sat it on top of the fridge. Once equipped with its transformer, the fridge ran reliably for their three years in Singapore.

In 1970, Fred's job took the family to Washington DC, where he took over as Chief of *The Times*' Washington Bureau. Once again, the fridge, the washing machine and the dryer came too. Unconvinced in retrospect that it made sense to have taken the fridge all that way, Marianne commented "you might have thought at that point we'd have sold them to somebody in Singapore instead of taking them to America," given that similar products were readily available there. But in Fred's eyes, "they were *perfect*, only three years old," suggesting that in 1970 a three-year-old appliance could still be considered 'new' in a way that it would not today. The mobility of these domestic objects was made possible by the circumstances of Fred's employment with *The Times*: "they paid for the move, so we took them." Back in the United States, obviously the fridge could operate directly from the mains again, but here the Emerys encountered another cultural difference in the way kitchens were equipped. It was normal in the United States for a house to come complete with appliances. As a refrigerator was already supplied, the Whirlpool became the Emery's 'second fridge,' located in the garage and used for six months or so each year, for drinks in the summer or when they needed extra storage space for parties or at Christmas.

In 1977, they were posted back to London. They sold or gave away their other appliances but, courtesy of *The Times*, the fridge accompanied them once more. Fred told me that "Marianne couldn't imagine, even in a small kitchen, being without that fridge." As in Washington DC, it functioned as a second fridge, located just outside the door that opened from the kitchen into the garage. From 1977, the Emerys happily ran their Whirlpool on the same transformer that they purchased back in Singapore, right up until 2000 when they donated both fridge and transformer to the Science Museum (Figures 6.13 & 6.14).

Figure 6.13 The Emery's 1966 Whirlpool fridge in the Science Museum Large Object Store

Figure 6.14 The transformer purchased in Singapore and mounted on a board by Fred



Source: own photographs

Belonging and mobility

During our conversation, Marianne commented that attitudes towards fridges differed between Britain and Sweden, where she grew up. Fridges were ‘normal’ there much earlier than they were in Britain. Her family had had one as long as she could remember. She described Swedish domestic culture as being oriented towards apartment-living, unlike Britain where houses are considered the norm and home ownership the customary aspiration. Appliances in Swedish apartments are commonly built-in and, as is the convention in the United States, they are left in situ when people move. Arriving in Britain in the 1950s, she was surprised to find that people took their white goods with them when they moved:

Marianne:	When we got married we did the same too. You took your cooker and you took your fridge with you. So they became something more than what I’d grown up with. There they were sort of ‘part of the walls,’ you know. For the English they were ‘possessions.’
Fred:	The Americans don’t move them either.
Marianne:	They belong to the house rather than to the people. So ours came all over the world with us because of, I think, our English background.

Fred reiterated that it was only thanks to *The Times*’ generous moving allowances for its foreign correspondents that the Whirlpool embarked upon its world tour and ultimately ended up as a museum piece; “had *The Times* not been paying for our move, I’m sure we wouldn’t have been paying for it ourselves. … I’m certain this fridge would never have left Japan had it not been for them.” Granted, the circumstances that enabled its movement were financial, but nevertheless Marianne raises a fascinating question about where the impetus to move one’s appliances originates. She attributes the mobility of this refrigerator to a peculiarly British mentality.

The issue of to whom or what appliances belong most fully is an equally intriguing one, as is her notion that in Britain, unlike Sweden or the United States, appliances have a stronger ‘attachment’ to their owners than to the spaces in which they reside. The subtly different sense of ownership with which white goods are imbued in British culture, which finds expression through their mobility, is a symptom of their history and their geography. Smaller than their American counterparts, usually free-standing, unlike in Sweden, and much later to be ‘normalised’ than in either, British refrigerators are rarely left in situ, but tend to accompany people when they move. Certainly in the 1950s and through the 1960s, refrigerators had not yet become sedimented as 'standard' kitchen fittings, and by the time they had, this norm had been established. The refrigerator was perceived to be an individualized object more than an integral part of a whole and, as an object of some value, there was no expectation that it should simply be left for the next resident. Instead, appliances generally go with their owners, or are at least negotiated separately from the sale of a house. And so refrigerators are routinely moved despite, as Doug at Respond was quick to emphasise, not being objects known to travel well.

The very hungry refrigerator: reliability and retirement

When they started renovating their kitchen in 2000, the Emerys had no intention of parting with the fridge now in the Science Museum. They felt a real attachment to it and took pride in it having run so well for so long. Fred was emphatic: "the fridge worked like a dream. I don't ever remember that fridge going wrong. In fact, we used to boast about it being so robust." The only replacement part it needed during its lifetime was a new thermostat in 1988, which Fred installed himself. "I'm a bit of a DIY chap," he explained, "I like doing these things." He had written to the manufacturer in Michigan who sent him a replacement, "free because they were so delighted. I've still probably got the letter somewhere saying how amazed they were that the fridge was still going strong." In fact, that letter now comprises part of the refrigerator's 'biography' preserved in the Science Museum's files. In it, Whirlpool's International Consumer Correspondent replied to Fred:

> Well, Sir, even I was surprised to learn that we can help you with your 21 year old Whirlpool appliance. I am instructing our Parts Center to forward to you via air at no charge the following parts … I am also instructing our Literature Department to forward to you at no charge the relevant Parts List so that should you require parts in the future, you will be able to order them by number. That is, of course, if they are still in stock.

Whirlpool's response reinforces the contemporary expectation that a fridge would not last for this length of time. The company expressed surprise that the fridge was still in use and, in keeping with Mike's earlier comments about companies limiting how long they keep spare parts, even greater surprise that they still stocked the appropriate part.

Marianne reminded Fred of a second repair, this time to one of the plastic shelves inside the fridge door. "Oh the plastic" he remembered, "that always breaks in fridges doesn't it." Just as in Grace's experience at the start of the chapter with the shelves that snap when cleaning them, so Fred regards plastic shelves as things that 'always break.' His comments tell us that he does not have high expectations about the durability of certain materials and knows from experience that some parts of a fridge are prone to damage over time. Improvising with a block of wood, some duct tape and a screw, he secured the broken lower shelf and the Emerys continued to store bottles in it (Figure 6.15).

Figure 6.15 Fred's DIY fridge repair

Source: own photograph

Fred's intervention is a very visible one. The fact that this fridge had been repaired is no secret and it illustrates nicely that repair is also a form of remaking, for the object can never be entirely the same afterwards. In a museum context, the obvious nature of this repair actually enhances the social value of this fridge in that an episode from the artifact's life history has been written upon its surface. Like Grace's husband Peter, Fred expressed satisfaction at having solved the problem and repaired the fridge himself. As 'a bit of a DIY chap' who likes doing these things, Fred's fridge repairs, and his sense of pride in doing them, were an expression of technical competence and a performance of masculine identity (Oldenziel 1999; Mellström 2004).

Despite his practical accomplishment, Fred would later learn that he was not as knowledgeable as he thought about other aspects of this machine. Although the Emerys had intended to keep the Whirlpool, their plans changed when they happened to discover that their trusty old refrigerator was hungrily consuming many times more power than a new one. During the kitchen redesign the topic of the refrigerator came up:

> We said to the man at the department store where we were buying the kitchen, 'well, one thing we're not going to have is a great big fridge-freezer because we've got this wonderful American Whirlpool fridge that has been going for thirty years.' And he said, you know the classic phrase, 'well of course they don't make them like that anymore, but have you ever considered how much electricity it's using?' So we said 'no, why?' And he said, 'well I think you might be in for a shock.' So we went home and turned everything off and checked it for a day. And there it was, it was using, well the whole of the electricity bill was going on this fridge! So we decided enough was enough. Even though we are fairly well informed about what's going on, that's when we first really focused on energy efficiency. So we went back and said 'ok, well we've got to have a new one!'

As the Emerys discovered to their cost, an inefficient refrigerator consumes a substantial proportion of domestic electricity. As well as their role in ozone depletion, refrigerators also have a global warming effect, due to the electricity produced to power them. Burning fossil fuels to generate electricity releases carbon dioxide, a 'greenhouse gas,' from power stations. As they accumulate in the atmosphere, greenhouse gases cause the surface of the earth to heat up by trapping UV radiation in the lower atmosphere instead of reflecting it back to out space. The heating effect is understood to cause climate change by altering global rainfall and temperature patterns (Molina 1997; Watson *et al* 1986). It is calculated that 85% of greenhouse gas emissions from refrigeration in the UK come from the energy produced to power them, compared to 15% from the refrigerants they contain, hence growing recognition of the importance of energy efficiency (DETR/DTI 2000, p. 16; Garnett 2007). Given the lifespan of a typical refrigerator, improvements in efficiency bring significant benefits in overall energy consumption over the total lifecourse of this appliance (Radermacher & Kim 1996, p. 62). So, after sitting in their London home from 1977 to 2000, "eating all our electricity," the Emerys finally retired their well-travelled Whirlpool. They calculated that with the energy saving, a new one would pay for itself within a year.

Just as the decision to get rid of the Whirlpool arose from a discussion about energy efficiency, so the fridge's journey to the museum was prompted by a subsequent conversation on this topic. After their shock at how much energy it was consuming, the Emerys told all their friends why they were replacing their fridge, wanting to spread the word in case their friends were similarly unaware of their own refrigerators' appetites for electricity. Fred found that "many people were interested in this because they've all got old fridges, because fridges last forever, and nobody thinks that they're using electricity like it's going out of style." Reliable and durable older fridges may be, but, as the Emerys discovered by monitoring their electricity consumption, efficient they are not. Rightly suspecting that the Indesit fridge in their kitchen was also consuming a lot of power, they decided to get rid of both, but were loathe to simply discard them. "We're very anti throwing away if something works" stressed Fred. And so their fridge dilemma found them caught between competing sets of values. They were well aware that excessive energy consumption was expensive and environmentally harmful, and yet throwing away a working machine seemed to them both wasteful and immoral. In the hope that someone might find it useful, they gave the Indesit to a charity along with some other household goods, but found no takers for the Whirlpool because people were wary about using the transformer. The Emerys were at a loss for what to do until they told the story to a friend who asked if they had ever thought of donating it to a museum. To their great surprise and delight, the Science Museum was very keen to accept the Whirlpool. "Oh it was such a hoot" laughed Marianne. She confessed to having been rather nervous when the Curator came to view it:

> I thought, he's going to come in, laugh and go home again. But not at all. He was all 'ah' and 'wow.' … It was very rectangular, that was what caught the Curator's eye. He was so glad it wasn't 'retro.' It was rectangular and it had very classy plastic designs on the inside.

The case made by the Curator of the Domestic Appliance Collection to acquire this object rested on both its representativeness and its uniqueness. The Whirlpool's shape and modern style made an impact on him and on the museum's Proposal Acquisition Form (Technical file 2000-1168), he writes that "this American refrigerator fills a gap in our refrigerator collection for the decade of the 1960s, for which we have no examples." Standing for a decade of engineering and design, this object serves to fill a knowledge gap. In addition to its intrinsic interest as a 1960s American appliance, the Whirlpool's biography and its travels make it a noteworthy object and the Curator was able to strengthen the case for acquisition by emphasising that "this example is well provenanced and travelled around the world with its owner … Fred Emery." The fact that this appliance had been owned by a figure from British journalism and broadcasting turned it into an artifact of broader cultural interest. As well as the object in and of itself, various records connected to it are also highly important sites of knowledge as these attest to its provenance, give it authority and afford it value. The story of the Whirlpool is well recorded and supported with documents, correspondence, photographs, notes from conversations with Emery himself and, after my own interview, also an oral recording. Though not integral to the object physically, these nevertheless become important 'extensions' of the refrigerator into different media, material traces of it in the form of text, sound and image preserved upon tape and paper.

Preserving a technology of preservation

Andrew Ellis, the Museum's Curator of domestic technology, arranged for the fridge to be collected from the Emerys' home and taken to the museum's 'Large Object Store,' situated in a hangar on a former airfield in Wroughton, eighty miles west of London. When the fridge arrived, it was examined, measured, photographed and catalogued before finally being positioned in its allotted space on the mobile storage racks (Figure 6.16).

Figure 6.16 The Science Museum's climate-controlled Large Object Store

Source: own photograph

The hangar is a purpose-built climate-controlled container. Constructed without windows, to protect artifacts from being bleached by sunlight, it is fully air conditioned and its temperature and humidity levels are constantly monitored. All people and objects moving in and out of the building pass through an airlock so that, as far as possible, a stable 'sealed' environment can be maintained. In effect, the refrigerator now resides inside a giant fridge itself, where it is being preserved to minimise its physical decay.

It so happened that this old fridge, the large American Whirlpool, was collected by the Science Museum at exactly the same time as the Emerys' brand new fridge, a large American Maytag, was delivered. They described their amusement at the contrast between the two teams of delivery men and their handling of these two objects:

> We were so tickled really. We couldn't believe it, the men coming to take it away, with 'Science Museum' on their sweatshirts, and they were treating it with great delicacy. They came the same day as the Maytag was delivered. The men delivering the Maytag were rather off-hand, and the Science Museum guys said 'excuse me, do you mind, you must go very carefully with that because in 35 years time we might be coming to get it!' And they thought he was mad! … They were looking at these guys carefully taking this old fridge out, amazed that the old one was going off to the Science Museum, and the Science Museum movers were much more gentle with everything. Very careful. It was very funny."

I was fascinated by the image of the juxtaposition of these two fridges, one leaving the home as the other arrived. Here were two examples of ostensibly the same object being treated in strikingly different ways, the irony being that the old and rather battered one was afforded more value and respect than the shiny new one.

> Me: That's interesting, the idea of the two being treated as very different kinds of objects.
> Fred: Yes, one object was now a kind of relic.

The bemusement of the Maytag delivery men at the fact that an old fridge should be deemed worthy of a place in a museum, and a museum of science at that, helps illustrate the unusual transformation which the Whirlpool underwent. From a rather ordinary fridge, once largely indistinguishable from the thousands of others coming off Whirlpool's production line in 1966, this one had outlived the rest to become something more significant. In 2000, it changed ownership, changed location and its status was 'elevated' from an everyday household appliance to a museum artifact. By the time it was carried out of the house by those careful men in their blue sweatshirts, the Whirlpool was no longer 'just' a fridge,' but an item of historic significance.

In our conversation, Andrew, the Curator, alerted me to an interesting shift in the museum's rationale. He explained that many people were unaware that the principle of the museum collecting 'historically' is actually relatively recent and emerged only in the postwar period:

> Before that … this was very much a state-of-the-art contemporary practice museum. This was a place where artisans came to learn the latest tools and methods. Right up to the 1930s, the kind of exhibits we were showing or borrowing were 'up to date.'

Historically, the museum was not overly 'historical' at all but was a place where innovative 'cutting-edge' machinery was exhibited, primarily for the benefit of people working within industry. As such, it was less an esteemed repository of formal abstract knowledges than a site for practical learning through demonstration and observation. It may not have shared quite the theatrics of the Harrods window display, but there are certainly parallels with the opening scene in Harrods where we began and with the process of assembling objects, bodies, ideas and images as a way to help knowledges travel and practices cohere.

Part of the museum's mission is to collect objects and preserve them in controlled conditions in order to prolong their 'shelf live' and keep them 'fresh' as information sources for future generations. Now that it is part of Britain's collection of scientific and industrial heritage, the Whirlpool refrigerator belongs to the nation. It has embarked on a new career as an artifact that can speak in some small way to relationships between science, technology, industry and domesticity and it remains preserved as a resource for constructing future refrigerator knowledges.

BIBLIOGRAPHY

Adams, E. D. (1927) *Niagara Power: History of the Niagara Falls Power Company 1886-1918*. Niagara Falls, NY, Niagara Falls Power Company.

Adams, J. (1995) The Promotion of New Technology through Fun and Spectacle: Electricity at the World's Columbian Exposition. *Journal of American Culture*, 18(2), 45-55.

Ágoston, G., Millward J. & Sand, J. (eds) (2001) The Century of Human Hegemony: An Interview with John McNeill. *History at Georgetown Newsletter 2001*. pp. 7-9. http://www1.georgetown.edu/departments/history/resources/deptnewsletters/01newsletter.pdf

Akrich, M. (1992) The de-scription of technical objects. *In*: W. Bijker & J. Law (eds) *Shaping Technology/Building Society: studies in sociotechnical change*. Cambridge, MA, MIT Press. pp. 205–224.

Albion, R. G. & Pope, J. B. (1939) *The Rise of New York Port (1815-1860)*. New York, Charles Scribner's Sons.

Allen, J. (2000) Power/economic knowledge: symbolic and spatial formations. *In*: J. R. Bryson, P. W. Daniels, N. Henry & J. Pollard (eds) *Knowledge, Space, Economy*. London, Routledge. pp. 15-33.

Andersen, S. O. & Sarma, K. M. (2002) *Protecting the Ozone Layer: The United Nations History*. London, Earthscan.

Anderson, O. E. (1953) *Refrigeration in America*. Princeton, NJ, Princeton University Press.

Appadurai A. (ed) (1986) *The social life of things: commodities in cultural perspective*. Cambridge & New York, Cambridge University Press.

Arcon (1948) The design, organisation and production of a prefabricated house. *Building*, XXIII(3), 77-80.

Attfield, J. (2000) *Wild Things: The Material Culture of Everyday Life*. Oxford, Berg.

Aubrey, J. (1949) *Brief Lives*. Edited from the original manuscripts and with an introduction by O. L. Dick. London, Secker & Warburg.

Bacon, F. (1620) *Novum Organum: Or true directions concerning the interpretation of nature*. London.

Bacon, F. (1627a) *Sylva Sylvarum, Or, a Naturall Historie in Ten Centuries*. London, William Lee.

Bacon, F. (1627b) *The New Atlantis*. Available online from Project Gutenberg, http://www.gutenberg.org/etext/2434

Bancroft, H. H. (1893) *The Book of the Fair: An Historical and Descriptive Presentation of the World's Science, Art and Industry, As Viewed through the Columbian Exposition at Chicago in 1893*. Chicago & San Francisco, The Bancroft Company.

Barnes, T. (2003) The place of locational analysis: a selective and interpretive history. *Progress in Human Geography*, 27(1), 69-95.

Barnstable, N. (1953) The Problem of the Slums and the Substandard House. *British Housing and Planning Yearbook 1953*. National Conference and Exhibition of the National Housing and Town Planning Council, Eastbourne, October 28-30, pp. 43-48.

BBC (1944) *Homes for All*. Worcester, Littlebury.

BBC (2002) Thousands of fridges are being put into store. *Southampton News*. http://www.bbc.tv.southampton/news/022002/1/fridges.shtml

BBC (2005) Do you waste food? *BBC News*. Tuesday April 19th, http://news.bbc.co.uk/1/hi/talking_point/4446277.stm

Beck, U. (1992) *Risk Society: Towards a New Modernity*. Translated by M. Ritter. London, Sage.

Beecher, C. (1841) *A treatise on domestic economy*. Boston, Marsh, Capen, Lyon & Webb.

Beeton, I. (1861) *The book of household management*. London, S. O. Beeton.

Belich, J. (2002) *Paradise Reforged: A History of the New Zealanders from the 1880s to the Year 2000*. Aukland, Penguin.

Bell, C., Dobson, F., Etchells, F., Grant, D., John, A., Moore, H., Reilly, C. & Smith, M. (1944) Portal Houses. Letter to the Editor. *The Times*, September 1st, p. 5.

Benedick, R. E. (1991) *Ozone Diplomacy: New Directions in Safeguarding the Planet*. Cambridge, MA, Harvard University Press.

Bennett, J. & Dixon, M. (2006) *Single Person Households and Social Policy: Looking Forwards*. York, The Joseph Rowntree Foundation.

Biswas, A. K. (ed) (1979) *The Ozone Layer: proceedings of the meeting of experts designated by governments, intergovernmental and nongovernmental organizations on the ozone layer organized by the United Nations Environment Programme in Washington DC, 1-9 March 1977*. Oxford & New York, Pergamon Press.

Blain, B. B. (2006) *Melting Markets: The Rise And Decline Of The Anglo-Norwegian Ice Trade, 1850-1920*. Working Papers of the Global Economic History Network, No. 20/06.

Blunt, A. & Dowling, R. (2006) *Home*. London, Routledge.

Booker, C. (2001) Recycling rules leave fridges out in the cold. Christopher Booker's Notebook. *The Telegraph*, October 7th, http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2001/10/07/nbook07.xml

Booth, J. (2002) A chilling prospect for Britain's countryside. *The Telegraph*, January 20th, http://www.telegraph.co.uk/education/main.jhtml?xml=/education/2002/02/02/tegdump02.xml

Bourdieu, P. (1977) *Outline of a theory of practice*. Translated by R. Nice. Cambridge & New York, Cambridge University Press.

Bourdieu, P. (1989) *The logic of practice*. Translated by R. Nice. Cambridge, Polity.

Bowden, S. & Offner, A. (1996) The Technological Revolution that Never Was: Gender, Class and the Diffusion of Electrical Appliances in Interwar England. *In*: V. de Grazia & E. Furlough (eds) *The Sex of Things: Gender and Consumption in Historical Perspective*. Berkeley, University of California Press. pp. 244-274.

Bowlby, S., Gregory, S. & McKie, L. (1997) 'Doing Home': Patriarchy, caring and space. *Women's Studies International Forum*, 20(3), 343-50.

Boyd, H. W. & Piercy, I. (1963) Retailing in Great Britain. *Journal of Marketing*, 27(1), 29-35.

Boyle, R. (1660) *New Experiments Physico-Mechanicall, Touching the Spring of the Air and its Effects*. Oxford.

Boyle, R. (1665) *New Experiments and Observations Touching Cold: An Experimental History of Cold Begun*. London.

Brand, S. (1994) *How Buildings Learn: What Happens after They're Built*. New York, Penguin.

Breedlove, L. B. (1932) The Ice Industry: Its Economics and Future. *The Journal of Land & Public Utility Economics*, 8(3), 234-247.

Broad, C. D. (1926) *The Philosophy of Francis Bacon*. An Address Delivered at Cambridge on the Occasion of the Bacon Tercentenary, 5 October 1926. Cambridge, Cambridge University Press.

Brogan, M. (1997) *Home sweet home: A nostalgic look at domestic duties since 1945*. Kettering, Northamptonshire, Past & Present Publishing Ltd.

Brown, B. (2001) Thing Theory. *Critical Inquiry*, 28(1), 1-22.

Bryant, C. D. (2007) *R. V. Refrigeration: Theory of Operation*. http://bryantrv.com/reefer.html

BTH (1932) *How to take care of your BTH Electric Refrigerator*. Instruction Card. London, BTH.

BTH (1943) *The Silent Servant: A Treasure Book for Housewives*. London, BTH.

Budd, W. (1849) *Malignant cholera, its mode of propagation and its prevention*. London.

Buttimer, A. (1980) Home, reach and the sense of place. *In*: A. Buttimer & D. Seamon (eds) *The Human Experience of Space and Place*. New York, St Martin's Press.

Capie, F. (2004) Borthwick, Sir Thomas (1835–1912). *Oxford Dictionary of National Biography*. Oxford, Oxford University Press. http://www.oxforddnb.com/view/article/46644

Carey, P. (2004) Fines for dumping 6,000 fridges. *Western Mail*, January 29th, p. 12.

Carnot, S. [1824] (1960) *Reflections on the Motive Power of Fire*. New York, Dover.

CFA (1994) *CFA Fridgeometer promoted food hygiene in the home*. Press release from the Chilled Food Association. Jenny Webb's personal papers.

CCFRA (Campden and Chorleywood Food Research Association) (2004) *Evaluation of Shelf Life for Chilled Foods*. Technical Manual No. 28. Chipping Campden, Gloucestershire, CCFRA.

Chapman, T. & Hockey, J. (eds) (1999) *Ideal Homes: Social change and domestic life*. London, Routledge.

Chester, H. (1867) *Journal of the Society of Arts*, XV, January 4th, p. 100.

Churchill, W. (1944) The hour is approaching. *The Listener*, XXXI, 794, March 30th.

Cieraad, I. (1999) *At Home: An Anthropology of Domestic Space*. Syracuse, New York, Syracuse University Press.

Cieraad, I. (2002) 'Out of My Kitchen!' Architecture, Gender and Domestic Efficiency. *Journal of Architecture*, 7(3), 263-279.

Clover, C. & Evans-Pritchard, A. (2002) EU wrangle adding to the fridge mountain. *The Telegraph*, http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2002/02/07/nfrid07.xml

Cockburn, C. & Fürst Dilić, R. (eds) (1994) *Bringing technology home: Gender and technology in a changing Europe*. Buckingham & Philadelphia, The Open University Press.

Cockburn, C. & Ormrod, S. (1993) *Gender and Technology in the Making*. London, Sage.

Collier, J. D. (1803) *An Essay on the Law of Patents for New Invensions (and appendix catalogue of all patents granted from January 1, 1800 to the present time).* 2nd Edition. London, the author.

Concher, G. (n.d.) *Ten Freezer Misconceptions – or Whoever told you that?* Typed sheet, Jenny Webb's personal papers.

Cook, I. (2004) Follow the thing: papaya. *Antipode*, 36(4), 642-664.

Cooper, A. J. (1997) *The World Below Zero: A history of refrigeration in the UK*. Aylesbury, Buckinghamshire, ACR Today & Battlepress Ltd.

Cowan, R. S. (1983) *More work for Mother: The ironies of household technology from the open hearth to the microwave*. New York, Basic Books.

Cowan, R. S. (1985a) How the refrigerator got its hum. *In*: D. MacKenzie, & J. Wajcman (eds) *The Social Shaping of Technology: How the refrigerator got its hum*. Milton Keynes & Philadelphia, Open University Press. pp. 202-218.

Cowan, R. S. (1985b) The industrial revolution in the home. *In*: D. MacKenzie, & J. Wajcman (eds) *The Social Shaping of Technology: How the refrigerator got its hum*. Milton Keynes & Philadelphia, Open University Press. pp. 181-201.

Crawhall, T. C. & Lentaigne, B. (1934) *Refrigeration Exhibition: A brief account of the historical development of mechanical refrigeration and a descriptive catalogue of the exhibits, with notes on the basic scientific principles*. Board of Education, Science Museum. London, His Majesty's Stationery Office.

Critchell, J. & Raymond, J. (1912) *A history of the frozen meat trade*. London, Constable.

Cronon, W. (1991) *Nature's Metropolis: Chicago and the Great West*. New York, W. W. Norton.

Csikszentmihalyi, M. & Rochberg-Halton, E. (1981) *The meaning of Things: Domestic Symbols and the Self*. Cambridge, Cambridge University Press.

Cullen, W. (1756) Of the Cold produced by evaporating Fluids, and of some other means of producing Cold. *Essays and Observations, Physical and Literary*, volume 2, Edinburgh, pp. 145-56.

Cummings, R. O. (1940) *An American and His Food*. Chicago, Chicago University Press.

CVC (Central Valuation Committee) (1947) *Central Valuation Committee, Executive Committee, February 21st 1947 – Temporary Houses, prefabricated bungalows*. Paper No. E713, National Archive, file HLG 105/25 "Prefabricated Houses, 1944-1947."

Dagenham Borough Council (1956) *Municipal Tenants Handbook*. London, Dagenham Borough Council.

de Certeau, M., Giard, L. & Mayol, P. (1994) *The Practice of Everyday Life. Volume 2: Living and Cooking*. Translated by T. Tomasik. Minneapolis & London, University of Minneapolis Press.

DEFRA (2001) EC Regulation 2037/2000: Exports – Article 11, Correspondence from the Department of the Environment, Transport and the Regions to the European Commission, 8th January 2001, Select Committee on Environment, Food and Rural Affairs Minutes of Evidence.

de Laet, M. (2000) Patents, travel, space: ethnographic encounters with objects in transit. *Environment and Planning D: Society and Space*, 18(2), 149-168.

de Lauretis, T. (1987) *Technologies of Gender: essays on theory, film and fiction*. Bloomington, IN, Indiana University Press.

DeSilvey, C. (2006) Observed Decay: Telling Stories with Mutable Things. *Journal of Material Culture*, 11(3), 317-337.

DETR/DTI (Department of Environment, Transport and the Regions/Department of Trade and Industry) (2000) *Refrigeration and Air Conditioning CFC and HCFC Phase Out: Advice on Alternatives and Guidelines for Users*. London, HMSO.

DeVault, M. (1991) *Feeding the Family: The Social Organization of Caring as Gendered Work*. Chicago & London, University of Chicago Press.

Dickason, D. G. (1991) The Nineteenth-Century Indo-American Ice Trade: An Hyperborean Epic. *Modern Asian Studies*, 25(1), 53-89.

Donaldson, B., Nagengast, B. & Meckler, G. (1994) *Heat and Cold. Mastering the Great Indoors: A Selective History of Heating, Ventilation and Air Conditioning*. Atlanta, ASHRAE Transactions.

DoRDeC (1957a) Domestic Refrigeration Development Committee. *Domestic Refrigerator Guide*, 3(1), p. 3.

DoRDeC (1957b) Electrolux: The Millionth Domestic Refrigerator. *Domestic Refrigerator Guide*, 3(1), p. 5.

DoRDeC (1957c) Refrigeration Evening Exhibition. *Domestic Refrigerator Guide*, 3(3), p. 5.

DoRDeC (1959) Long-keeping test. *Domestic Refrigerator Guide*, 5(1), p. 5.

DoRDeC (1965) *Teaching Notes on Refrigeration*. London, C.S. Services Ltd, on behalf of DoRDeC.

DoRDeC (n.d.) *Do you need a refrigerator*. London, C.S. Services Ltd, on behalf of DoRDeC.

Douglas, J. (2002) *Toddler Troubles: coping with your under-5s*. Chichester, Wiley.

Douglas, M. (1992) *Risk and Blame: Essays in Cultural Theory*. London, Routledge.

Douglas, M. (1966) *Purity and danger: an analysis of concepts of pollution and taboo*. New York, Praeger.

Downey, G. L. (1998) *The Machine in Me: An Anthropologist Sits Among Computer Engineers*. New York, Routledge.

Drake, F. (1995) Stratospheric ozone depletion: an overview of the scientific debate. *Progress in Physical Geography*, 19,(1) 1-17.

Dupuis, A. & Thorns, D. (1998) Home, Home Ownership and the Search for Ontological Security. *The Sociological Review*, 46(1), 24-47.

Eassie, W. (1872) *Healthy Homes: a handbook to the history, defects, and remedies of drainage, ventilation, warming and kindred subjects*. New York, D. Appleton & Co.

East Midlands Electricity (n.d.) *Home Refrigeration*. Instruction leaflet, East Midlands Electricity.

Eastern Evening News (1966) Royal 'fridge goes into retirement at museum. *Eastern Evening News*, 9th May 1966.

Echikson, W. (2001) A Fridge at the Heart of the Family? *Business Week*, July 9th, http://www.businessweek.com/magazine/content/01_28/b3740133.htm

EDA (Electrical Development Association) (1955) *The Electric Kitchen and Household Aids. Handbook III, EDA Salesmanship Course.* London, British Electrical Development Association.

Edensor, T. (2005) Waste Matter: the Debris of Industrial Ruins and the Disordering of the Material World. *Journal of Material Culture*, 10(3), 311-332.

Edwards, E. (1935) *Report on Electricity in Working Class Homes*. London, Electrical Association for Women.

Ehrenreich, B. & English, D. (1979) *For her own good: 150 years of the experts' advice to women*. London, Pluto Press.

Electrical Review (1936) Progress in Refrigeration: A review of developments in the domestic field. *The Electrical Review*, 31, 568-70.

Electrolux (1950) *Electrolux Simplified Catering*. London, Electrolux Ltd.

Electrolux (2002) *ScreenFridge*. http://www.electrolux.se/screenfridge.

Elliot, M. A. (1918) The Frozen Meat Industry of New Zealand, *New Zealand Journal of Science and Technology*, 1.

Elliot, V. & Leroux, M. (2007) Growing food waste mountain blamed on get-one-free offers. *The Times*, Saturday March 17th, http://www.timesonline.co.uk/tol/news/uk/article 1527738.ece

Emerson, R. M., Fretz, R. I. & Shaw, L. L. (1995) *Writing Ethnographic Fieldnotes*. Chicago, University of Chicago Press.

ENDS (2001) *New recovery requirement looms for ozone depleters in fridges*. ENDS Report Bulletin 312. London, Haymarket Business Media Ltd.

England, K. (1993) Changing Suburbs, Changing Women: Geographic Perspectives on Suburban Women and Suburbanization. *Frontiers: A Journal of Women Studies*, 14(1), 24-43.

EPA (United States Environmental Protection Agency) (1987) *Assessing the Risks of Trace Gases That Can Modify the Stratosphere*. Washington DC, EPA.

ESA (Environmental Services Association) (2004) *EC Regulation No. 2037/2000 on Substances that Deplete the Ozone Layer*. Briefing. London, ESA. http://www.esauk.org/ work/briefings/fridge.asp

European Commission (2000) *Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer*. Brussels, European Commission. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri= CELEX:32000R2037:EN:NOT

Evans, G. I., Stanton, J. L., Russell, S. L. & James, S. J. (1991) *Consumer Handling of Chilled Foods: A Survey of Time and Temperature Conditions*. London, MAFF.

Evans, O. (1805) *The Abortion of the Young Steam Engineer's Guide*. Philadelphia, Fry & Kammerer.

Faraday, M. & Davy, H. (1823) On Fluid Chlorine. *Philosophical Transactions of the Royal Society of London*, 113, 160-165.

Farman, J. (1999) Will we learn? *Our Planet: The magazine of the United Nations Environment Programme*, 10(4), January, http://www.unep.org/OurPlanet/imgversn/104 /farman.html

Farman, J. C., Gardiner, B. G. & Shanklin, J. D. (1985) Large losses of total ozone in Antarctica reveal seasonal ClO_x/NO_x interaction. *Nature*, 315, 207-210.

Faulks, S. (2008) *Engleby*. New York, Vintage.

FDF (Food and Drink Federation) (1996) *National Food Safety Report*. London, Food and Drink Federation and the Institution of Environment Health Officers.

Ferree, M. M. (2003) Practice Makes Perfect? A Comment on Yancey Martin's Gendering Practices, Practicing Gender. *Gender and Society*, 17(3), 373-378.

FFRC (Food Freezer and Refrigerator Council) (1974) *Fridge and Freezer Fact Card*. London, FFRC.

FISS (Food Industry Sustainability Strategy Champions' Group on Waste) (2007a) Minutes of the 5th Meeting of FISS CGW, 30th January. http://www.defra.gov.uk/farm/policy /sustain/fiss/pdf/fiss-water-070130.pdf

FISS (2007b) *Report of the Food Industry Sustainability Strategy Champions' Group on Waste*. London, DEFRA. http://www.defra.gov.uk/farm/policy/sustain/fiss/pdf/report-waste-may2007.pdf

Ford, H. & Crowther, S. (1922) *My Life and Work*. Garden City, NY, Garden City Publishing Company.

Forty, A. (1992) *Objects of Desire: Design and Society Since 1750*. London, Thames & Hudson.

Foucault, M. (1991) Governmentality. *In*: G. Burchell, C. Gordon & P. Miller (eds) *The Foucault Effect: Studies in Governmentality*. Chicago, IL, University of Chicago Press. pp. 87-104.

Franklin, S., Lury, C. & Stacey, J. (2000) *Global Nature, Global Culture*. London, Sage.

Frederick, C. (1913) *The new housekeeping: efficiency studies in home management*. Garden City, NY, Doubleday, Page & Co.

Frederick, C. (1920) *Scientific Management in the Home*. London, G. Routledge & Sons.

Freeman, J. (2004) *The Making of the Modern Kitchen*. Oxford, Berg.

Frigidaire (1928) *Frigidaire Recipes*. Dayton, OH, Frigidaire Corporation.

FSA (Food Standards Agency) (2003) *Use by date Guidance Notes*. London, FSA. http://www.food.gov.uk/foodindustry/guidancenotes/labelregsguidance/usebydateguid

FSA (2004) *Consumer Attitudes to Food Standards Wave 4 – Wales Report*. Cardiff, FSA.

FSA (2007) *Labelling Terms*. http://www.eatwell.gov.uk/foodlabels/labellingterms/

Furnival, J. (1998) *Suck, Don't Blow*. London, Michael O'Mara Books.

Fürst, E. (1997) Cooking and Femininity. *Women's Studies International Forum*, 20(3), 441-449.

Fussell, G. E. (1956) Nineteenth Century Ice Importation. *Notes and Queries*, 3(3), 130-131.

Gallup (1992) *Gallup Report, Refrigerator Study. July 1992*. Refrigerator Survey S1283. Prepared for Barclay Stratton Ltd on behalf of The Electricity Association.

Garfield, E. (1992) Robert T. Watson of NASA Receives NAS Award for Scientific Reviewing of Stratospheric Ozone Dynamics. *Essays of an Information Scientist*, 15(17), 57-62. http://www.garfield.library.upenn.edu/essays/v15p057y1992-93.pdf.

Garnett, T. (2007) *Food Refrigeration: What is the Contribution to Greenhouse Gas Emissions and How might Emissions be Reduced?* Working Paper, Food Climate Research Network Centre for Environmental Strategy, University of Surrey.

GEC (1932) *The Silent Treasure Handbook*. London, GEC.

GHS (General Household Survey) (2002) *Living in Britain: results from the 2001 General Household Survey*. London, The Stationary Office.

Giddens, A. (1984) *The Constitution of Society: Outline of the theory of structuration*. Berkeley, University of California Press.

Giedion, S. (1948) *Mechanization Takes Command: a contribution to anonymous history*. New York, Oxford University Press.

Gigiel, A., Evans, J. & Hammond, E. (2001) Practical development of refrigerator circuits for small commercial and domestic refrigerators and freezers. *Proceedings of the Institute of Refrigeration*, 2001-02, 1-1.

Gilbreth, L. (1927) *The home-maker and her job*. New York, D. Appleton & Co.

Giles, J. (1995) *Women, Identity and Private Life in Britain, 1900-50*. New York, St Martin's Press.

Goffman, I. (1959) *The Presentation of the Self in Everyday Life*. New York, Doubleday.

Goldstein, M. & Goldstein, I. F. (1993) *The Refrigerator and the Universe: Understanding the Laws of Energy*. Cambridge, MA & London, Harvard University Press.

Gordon, B. (1984) *Early Electrical Appliances*. Princes Risborough, Shire.

Gorrie, J. (1854) *Dr John Gorrie's Apparatus for the Artificial Production of Ice in Tropical Climates*. Unpublished pamphlet.

Graham, S. & Thrift, N. (2007) Out of Order. Understanding Repair and Maintenance. *Theory, Culture and Society*, 24(3), 1-25.

Grahame, P. R. (1994) Objects, texts and practices: The refrigerator in consumer discourses between the wars. *In*: S. H. Riggins (ed) *The Socialness of Things: Essays on the socio-semiotics of Objects*. New York, Mouton de Gruyter.

Grant, C. (1862) *Anglo-Indian Domestic Life*. Calcutta, Thacker, Spink & Co.

Gregson, N. (2006) *Living with Things: ridding, accommodation, dwelling*. Oxford, Sean Kingston Publishing.

Grenthe, I. (1997) The Nobel Prize in Chemistry 1995 – Presentation Speech. *In*: B. G. Malmström (ed) *Nobel Lectures, Chemistry 1991-1995*. Singapore, World Scientific Publishing Co.

Gullestad, M. (1997) The home as an expressive statement. *In*: H. Mackay (ed) *Consumption and Everyday Life*. London, Thousand Oaks & New Delhi, Sage Publications, in association with The Open University. pp. 51-52.

Gurney, C. M. (1997) "… Half of me was satisfied": making sense of home through episodic ethnographies. *Women's Studies International Forum*, 20(3), 373-386.

Haas, P. M. (1992) Banning Chlorofluorocarbons: Epistemic Community Efforts to Protect Stratospheric Ozone. *International Organization*, 46(1), 187-224.

Hall, H. (1888) *The Ice Industry of the United States: with a brief sketch of its history*. Washington DC, United States Government Printing Office.

Habib, L. & Cornford, T. (2002) Computers in the home: domestication and gender. *Information Technology and People*, 15(2), 159-74.

Hamer, B. (2003) *Kitchen Stories*. BOB Film Sweden AB.

Hand, M. & Shove, E. (2007) Condensing Practices: Ways of living with a freezer. *Journal of Consumer Culture*, 7(1), 79-103.

Hannah, L. (1979) *Electricity before Nationalization: A Study of the Development of the Electricity Supply Industry in Britain to 1948*. London, Macmillan.

Hannerz, U. (2003) Being There... And There... And There! Reflections on Multi-Site Ethnography. *Ethnography*, 4(2), 201-16.

Hansard (2002) *House of Commons Official Report. Refrigerators.* Tuesday July 9th, http://www.publications.parliament.uk/pa/cm200102/cmhansrd/vo020709/halltext/20709h01.htm#20709h01_spnew41

Happold, T. (2002) Growning 'fridge mountains' leave some Brits steaming. *Christian Science Monitor*. March 26th. http://www.csmonitor.com/2002/0326/p07s01-woeu.html

Haraway, D. (1988) Situated Knowledge: The Science Question in Feminism as a Site of Discourse on the Privilege of Partial Perspective. *Feminist Studies*, 14(3), 575-99.

Hardy, A. (1993) *The Epidemic Streets: Infectious Disease and the rise of Preventative Medicine, 1856-1900*. Oxford, Clarendon Press, Oxford University Press.

Hardyment, C. (1992) *Home Comfort: A History of Domestic Arrangements*. London, Viking in association with the National Trust.

Hawkins, G. & Muecke, S. (eds) (2003) *Culture and Waste: The Creation and Destruction of Value*. Lanham, MD, Rowman & Littlefield.

Hawks, T. (1998) *Round Ireland with a fridge*. London, Ebury Press.

Hayden, D. (1985) *The Grand Domestic Revolution: A History of Feminist Designs for American Homes, Neighbourhoods and Cities*. Cambridge, MA & London, MIT Press.

Hayden, D. (2004) *Building Suburbia: Green Fields and Urban Growth, 1820-2000*. New York, Vintage.

Heap, T. (2005) Costing the Earth – The Best Meal You'll Never Have. *BBC Radio 4*, Wednesday April 14th.

Heidegger, M. (1971) *Poetry, Language, Thought*. Translated by A. Hofstadter. New York, Harper & Row.

Heizer, J. H. (1998) Determining responsibility for development of the moving assembly line. *Journal of Management History*, 4(2), 94 – 103.

Henderson, S. R. (1996) A Revolution in the Women's Sphere: Grete Lihotzky and the Frankfurt Kitchen. *In*: D. Coleman, E. Danze & C. Henderson (eds) *Architecture and Feminism*. New York, Princeton University Press.

Henke, C. R. (2000) The mechanics of workplace order: towards a sociology of repair. *Berkeley Journal of Sociology*, 43, 55-81.

Herman, J.R., Bhartia, P.K., Ziemke, J., Ahmad, Z. & Larko, D. (1996) UV-B increases (1979-1992) from decreases in total ozone. *Geophysical Research Letters*, 23(16), 2117-2120.

Hetherington, K. (2004) Secondhandedness: Consumption, Disposal, and Absent Presence. *Environment and Planning D: Society and Space*, 22(1), 157–73.

Higginson, I. & Smith, C. (1999) 'A magnified piece of thermodynamics': the Promethean iconography of the refrigerator in Paul Theroux's *The Mosquito Coast*. *British Journal for the History of Science*, 32, 325-342.

HoC EFRAC (House of Commons Environment, Food and Rural Affairs Committee) (2002) *Disposal of Refrigerators*. *Report, together with Proceedings of the Committee, Minutes of Evidence and Appendices.* Fourth Report of Session 2001-2, June 20th. London, The Stationary Office Ltd.

Honig, B. (1994) Difference, dilemmas, and the politics of home. *Social Research*, 61, 563-597.

hooks, b. (1990) Homeplace: a site of resistance. *In*: *Yearning: race, gender and cultural politics*. Boston, MA, South End Press. pp. 41-49.

Hopkins, S. (2005) Your friends may never know. *Los Angeles Times*, Thursday February 17th, http://www.latimes.com/features/home/la-hm-stainless17feb17,1,80712.story

Hubbard, J. (ed) (1985) We Thought It was Heaven Tomorrow, 1945-1955. *People's History of Yorkshire*. Volume XIV. Pontefract, Yorkshire Art Circus.

Hudson P. K. & Hartwell H. J. (2002) Food safety awareness of older people at home: a pilot study. *The Journal of the Royal Society for the Promotion of Health,* 122(3), 165-169.

Ice and Refrigeration (1930) The Future of Ice. *Ice and Refrigeration*, 79, 307-8.

IFT (Institute of Food Technologists) (1995) Scientific status summary – Foodborne illness: role of home food handling practices. *Food Technology*, 49(4), 119-31.

Inness, S. (2001) Introduction: thinking food/thinking gender. *In*: S. Inness (ed) *Kitchen Culture in America: popular representation of food, gender and race*. Philadelphia, University of Pennsylvania Press. pp. 1-12.

Isenstadt, S. (1998) Visions of plenty: refrigerators in America around 1950. *Journal of Design History*, 11(4), pp. 311–321.

ISFT (Institute of Food Science and Technology, UK) (1993) *Shelf life of foods – Guidelines for its Determination and Prediction*. London, IFST.

Jackson P. (1999) Commodity cultures: the traffic in things. *Transactions of the Institute of British Geographers*, 24, 95-108.

Jacobs, J. M. (2006) A geography of big things. *Cultural Geographies*, 13(1), 1-27.

Jacobs, J. & Nash, C. (2003) Too little, too much: cultural feminist geographies. *Gender, Place and Culture*, 10(3), 265–279.

Johnson, A. E., Donkin, A. J., Morgan, K., Lilley, J. M., Neale, R. J., Page, R. M. & Silburn, R. (1998) Food safety knowledge and practice among elderly people living at home. *Journal of Epidemiology and Community Health*, 52(11), 745-748.

Johnson, J. (aka Latour, B.) (1988) Mixing Humans and Nonhumans Together: The Sociology of a Door-Closer. *Social Problems*, 35(3), 298-310.

Jones, E. G. (1929) The Argentine Refrigerated Meat Industry. *Economica*, 26, 156-72.

Jones, J. C. (1984) *America's Icemen: An Illustrative History of the United States Ice Industry 1665-1925*. Humble, TX, Jobeco Books.

JSRAE (2002) *Half a Century Cooling with Fire*. Tokyo, JSRAE.

Kaufman, J-C. (1998) *Dirty Linen: couples and their laundry*. Translated by H. Alfrey. London, Middlesex University Press.

Keller, E. F. (1985) *Reflections on Gender and Science*. New Haven & London, Yale University Press.

Kelvinator (1977) *Kelvinator Past and Present*. Commemorative leaflet, Open Day 1977.

King, A. (1984) *The Bungalow*. London & Boston, Routledge and Keegan Paul.

Kingery, W. D. (ed) (1996) *Learning from Things: Method and Theory of Material Culture Studies*. Washington & London, Smithsonian Institution Press.

Kipling, R. (1911) *The Second Jungle Book*. New York, Charles Scribner's Sons.

Kitchen, C. W. (1949) Fresh fruit and vegetable distribution. *Journal of Marketing*, 14(2), 325-329.

Kjeldsen, P. & Jensen, M. H. (2001) Release of CFC-11 from Disposal of Polyurethane Foam Waste. *Environmental Science and Technology*, 35(14), 3055 -3063

Klann, W. C. (1955) *Reminiscences of W.C. Klann*. Ford Motor Company archives, Research Center, Henry Ford Museum, Dearborn, MI.

Kopytoff, I. (1986) The cultural biography of things: commoditization as process. *In*: A. Appadurai (ed) *The Social Life of Things: Commodities in Cultural Perspective*. London. Cambridge University Press. pp. 64-94.

Lally, E. (2002) *At Home with Computers*. Oxford, Berg.

Latour, B. (1988) *The Pasteurization of France*. Translated by A. Sheridan & J. Law. Cambridge, MA, Harvard University Press.

Latour, B. (1990) Drawing Things Together. *In*: M. Lynch & S. Woolgar (eds) *Representation in Scientific Practice*. Cambridge, MA, MIT Press. pp. 19-68.

Latour, B. (1992). Where are the Missing Masses? The Sociology of a Few Mundane Artifacts. *In*: W.E. Bijker & J. Law (eds) *Shaping Technology/Building Society: Studies in Sociotechnical Change*. Cambridge, MA, MIT Press. pp. 225-258.

Latour, B. (1999) *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA, Harvard University Press.

Latour, B. & Woolgar, S. (1986) *Laboratory Life: The Social Construction of Scientific Facts*. Princeton, Princeton University Press.

Law, J. (2000) *Ladbroke Grove,Or How to Think about Failing Systems*. Online publications, Department of Sociology, Lancaster University. http://www.lancs.ac.uk/fass/sociology/research/restopic.htm

Leavitt, S. (2002) *From Catharine Beecher to Martha Stewart: a cultural history of domestic advice*. Chapel Hill, University of North Carolina Press.

Lie, M. & Sorensen, K. (1996) *Making Technology Our Own? Domesticating Technology into Everyday Life*. Oslo, Scandinavian University Press.

Llewellyn, M. (2002) *Domestic Modernities: The Experience of Architecture, Planning and Home, 193-53*. Unpublished PhD thesis, University of Wales Swansea.

Llewellyn, M. (2004) Designed by women and designing women: gender, planning and the geographies of the kitchen in Britain 1917-1946. *Cultural Geographies*, 11(1), 42-60.

Lohan, M. (2000) Constructive Tensions in Feminist Technology Studies. *Social Studies of Science*, 30(6), 895-916.

London County Council (1933) *Becontree Tenants Handbook*. London: LCC.

Lovelock, J. E. (1974) The Electron Capture Detector: theory and practice. *Journal of Chromatography*, 99(1), 3-12.

Lovelock, J. E. (1997) Travels with an Electron Capture Detector. *Resurgence*, 187, from the acceptance speech given at the Blue Planet Prize award ceremony, Tokyo, 29th October 1997, http://www.resurgence.org/resurgence/issues/lovelock187.htm

Lovelock, J. E., Maggs, R. J. & Wade R. J. (1973) Halogenated hydrocarbons in and over the Atlantic. *Nature*, 241(5386), 194-6.

Lucas, G. (2002) Disposability and dispossession in the twentieth century. *Journal of Material Culture*, 7(1), 5-22.

Lupton, E. (1993) *Mechanical Brides: women and machines from home to office*. New York, Cooper-Hewitt National Museum of Design, Smithsonian Institution; Princeton, Princeton Architectural Press.

Lynch, M. (1985) *Art and Artifact in the Laboratory*. London, Routledge.

MAF (Ministry of Agriculture and Fisheries) (1925) *Report on the trade in refrigerated beef, mutton and lamb*. London, HMSO.

MAFF (Ministry of Agriculture Fisheries and Food) (1991) *Food Safety: A Guide from the Food Safety Directorate*, London, Food Sense.

Marcellus, K. (2005) 'Talk to the Fridge 'cause the Stove ain't Listening': Interacting with Smart Domestic Technologies. Seminar paper, Sociology Seminar Series, Queen's University, March 24th 2005.

Marcoux, J. S. (2001) The '*casser maison*' ritual: constructing the self by emptying the home. *Journal of Material Culture*, 6(2), 213-135.

Marcus, G. E. (1995) Ethnography in/of the world system: the emergence of multi-sited ethnography. *Annual Review of Anthropology*, 24, 95-117.

Martens, L. & Scott, S. (2004) *Domestic Kitchen Practices: Routine, Reflexivity and Risk.* ESRC End of Award Report.

Martin, B. & Mohanty, C. T. (1986) Feminist politics: what's home got to do with it? *In*: T. de Lauretis (ed) *Feminist studies/Cultural studies*. Bloomington, Indiana University Press. pp. 191-212.

Maschio, T. (2002) The refrigerator and American ideas of 'Home.' *Anthropology News*, 43(5), p. 8.

Massey, D. (1992) A place called home? *New Formations*, 17, 3-15.

Matly, M. (2005) *Women's Electrification*. Report of the Collaborative Research Group on Gender and Energy with support from the ENERGIA International Network on Gender and Sustainable Energy and the United Kingdom Department for International Development. http://www.energia.org/resources/reports/2005_finrep_matly.pdf

Matthews, M. L. (1924) The development of women's interest in the domestic uses of electricity. *Woman Engineer*, 2, 5-8.

Mays, W. H. (1880) On the Supposed Identity of the Poisons of Diphtheria, Scarlatina, Typhoid Fever, and Puerperal Fever. *San Francisco Western Lancet*, 9, 110-5.

McCann, J. (2002) New shredding line also captures CFCs – Scrap – MeWa refrigerator recycling plant's new recovery process. *American Metal Market*, February 18th, http://goliath.ecnext.com/coms2/gi_0199-1421835/New-shredding-line-also-captures.html

McDermott, P. (2003) *Whitegood Mischief*. Paul McDermott: Case File. http://www.geocities.com/tangawarra/paulwri15.html

McNeill, J. R. (2000) *Something New Under the Sun: An Environmental History of the Twentieth-Century*. New York, W. W. Norton & Co.

Mellström, U. (2004) Machines and Masculine Subjectivity: Technology as an Integral Part of Men's Life Experiences. *Men and Mascinlinities*, 6(4), 368-382.

Midgley, T. & Henne, A. (1930) Organic fluorides as refrigerants. *Industrial and Engineering Chemistry*, 22, 542-547.

Miller, D. (ed) (1998) *Material Cultures: why some things matter*. London, UCL Press.

Miller, D. (ed) (2001) *Home Possessions: material culture behind closed doors*. Oxford, Berg.

Miller, H. (1985) *Halls of Dartford 1785-1985*. London, Hutchinson Benham.

Miller, W. (2002) *Refrigerator Rights: Creating Connections and Restoring Relationships*. New York, Perigee.

Ministry of Health/Ministry of Works (1944) *Temporary Accommodation: Memorandum for the Guidance of Local Authorities*. London, HMSO.

Mitchell, T. (2002) *The Rule of Experts*. Berkeley, CA, University of California Press.

MOA (Mass-Observation Archive) (1991) *New technology, Autumn Directive 1991 part 2*. MOA, University of Sussex.

Molina M. J. & Rowland F. S. (1974) Stratospheric sink for chlorofluoromethanes: chlorine atom-catalysed destruction of ozone. *Nature*, 249, 810-812.

Molina, M. J. (1997) Saving the shield. *Our Planet: The magazine of the United Nations Environment Programme*, 8(5), January, http://www.unep.org/OurPlanet/imgversn/85/molina.html

Morgan, Q. (1985) Time passes by a house of secrets. *Evening Post*, October 29th, p. 18.

Morley, D. (2003) What's 'home' got to do with it? Contradictory dynamics in the domestication of technology and the dislocation of domesticity. *European Journal of Cultural Studies*, 6(4), 435–458.

Morrisette, P. M. (1989) The evolution of policy responses to stratospheric ozone depletion. *Natural Resources Journal*, 29, 793-820.

MoWL (Museum of Welsh Life) (2004) Prefab Kitchen, Museum of Welsh Life, c.1950. http://www.tlysau.org.uk/en/item1/14158

Mumford, L. (1966) *Technics and human development*. New York, Harcourt Brace Jovanovich.

Munro, M. & Madigan, R. (1999) Negotiating space in the family home. *In*: I. Cieraad (ed) *At Home: an anthropology of domestic space*. Syracuse, Syracuse University Press. pp. 107-117.

Neuhaus, J. (1999) The way to a man's heart: gender roles, domestic ideology, and cookbooks in the 1950s. *Journal of Social History*, 32(3), 529-55.

Nickles, S. (2002) Preserving Women: Refrigerator Design as Social Process in the 1930s. *Technology and Culture*, 43(4), 693-727.

Northamptonshire Food Liaison Group (2003) *Food Safety for Childminders*. Newsletter, January 2003.

O'Brien, M. (1999) Rubbish Values: reflections on the political economy of waste. *Science as Culture*, 8(3), 269-295.

O'Connell, S. (2005) Credit, debt and guilt: cultural and moral obstacles to the development of consumer society. *In*: N. Ó'Ciosáin (ed.) *Explaining cultural change: The proceedings of the Irish conference of historians 2000*.

Oakley, A. (1975) *The Sociology of Housework*. New York. Pantheon.

Oakley, A. (2002) *Gender on Planet Earth*. Cambridge, Polity Press.

Oldenziel, R. (1999) *Making Technology Masculine: Men, Women and Modern Machines in America, 1870-1945*. Amsterdam, Amsterdam University Press.

Organ, M. & Turnidge, F. (2006) *E. D. Nicolle – Australian Pioneer of Refrigeration*. http://www.michaelorgan.org.au/nicol1.htm

Ormrod, S. (1994) 'Let's nuke the dinner': discursive practices of gender in the creation of a new cooking practice. *In*: C. Cockburn & R. Fürst Dilic (eds) *Bringing Technology Home: gender and technology in a changing Europe*. Buckingham, Open University Press. pp. 42-58.

Orr, J. (1996) *Talking about Machines: Ethnography of a Modern Job*. Ithaca, NY, Cornell University Press.

Osborn, F. J. (ed) (1946) *Planning and Reconstruction*. London & New York, Todd Publishing Company Ltd.

Pantzar, M. (1997) Domestication of everyday life technologies: dynamic views on the social histories of artifacts. *Design Issues*, 13(3), 52-65.

Pantzar, M. (2003) Constructing need – Tools or Toys. *Journal of Advertising*, 32(1), 81-91.

Parr, J. (1999) *Domestic Goods: The Material, the Moral, and the Economic in the Postwar Years.* Toronto, University of Toronto Press.

Partington, A. (1989) The Designer Housewife in the 1950s. *In*: J. Attfield & P. Kirkham (eds) *A View from the Interior: Feminism, Women and Design*. London, The Women's Press.

Paxton, A. (1994) *The Food Miles Report*. London, Sustainable Agriculture, Food and Environment Alliance.

Pearson, A. (2005) Carbon dioxide – new uses for an old refrigerant. *International Journal of Refrigeration*, 28(8), 1140-1148.

Pennington, M. E. (1924) *Care of the Home Refrigerator*. Chicago, National Association of Ice Industries.

Pennington, M. E. (1926) *Why We Refrigerator Foods*. Chicago, National Association of Ice Industries.

Pennington, M. E. (1927) *Cold is the Absence of Heat*. Household Refrigeration Bulletin number 8. Chicago, National Association of Ice Industries.

Pennington, M. E. (1928) *Journeys with Refrigerated Foods: Eggs*. Chicago, National Association of Ice Industries.

Pennington, M. E. (1930) *Buying a Refrigerator*. Chicago, National Association of Ice Industries.

Perren, R. (1971) The North American Beef and Cattle Trade with Great Britain, 1870-1914. *The Economic History Review*, NS 24(3) 430-444.

Perren, R. (1978) *The meat trade in Britain, 1840-1914*. London, Routledge and Kegan Paul.

Pickering, K. C. (1989) The refrigerator as a medium for family communication and expression: a preliminary investigation. Unpublished MA Thesis, California State University.

Pink, S. (2004) *Home Truths: Gender, Domestic Objects and Everyday Life*. Oxford, Berg.

Polanyi, M. (1967) *The Tacit Dimension*. New York: Anchor Books.

Power, R. (2000) *A Question of Knowledge*. Harlow, England, Pearson Education.

Pratt, G. (1999) Marking boundaries: Geographies of identity and difference. *In*: D. Massey, J. Allen & P. Sarre (eds) *Human Geography Today*. Malden, MA, Polity Press. pp. 151-167.

Prestcold (1943) *Cold Cookery*. London, Prestcold.

Princess (1952) *All you need to know about your Princess TD 50*. London, Princess.

Prudential (2004) *Soggy Lettuce Report 2004: Are we a nation of wasters?* http://www.assurre.eu/uploads/documents/13-1-soggy_lettuce_report_2004.pdf

Pursell, C. (1999) Domesticating modernity: the Electrical Association for Women, 1924-86. *British Journal for the History of Science*, 32, 47-67.

Quarmby, B. (1936) Electrical Refrigeration Prospects. *The Electrical Review*, 31, 170-171.

Radermacher, R. & Kim, K. (1996) Domestic refrigerators: recent developments. *International Journal of Refrigeration*, 19(1), 61-9.

Raimi, R. (1998) EB Odds & End. *A Newsletter of Eagles Byte Historic Research*, 29, March 1998, http://home.eznet.net/~dminor/O&E9803.html

Randell, W. L. (1945) *Electricity and Women: Twenty-One Years of Progress*. London, The Electrical Association of Women.

Ravetz, A. (1995) *The place of home: English domestic environments, 1914-2000*. London & New York, E. & F.N. Spon.

Reckwitz, A. (2002) Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory*, 5(2), 243-263.

Reece, S. H. & Roberts, G. K. (1998) 'This Electric Age is Woman's Opportunity': The Electrical Association for Women and its All-Electric House in Bristol, 1935. *Local Historian*, 38, 94-107.

Respond (n.d.) *Bringing New Ideas and Services to Your Community*. Information booklet, Respond.

Rhodes, P. (2004) Luxury of life in a fabulous prefab. Midlands Life, 27th May, Expressandstar.com.

RICA (Research Institute for Consumer Affairs) (1969) *The Disabled User. RICA Comparative Test Report No. 1. REFRIGERATORS.* London, The National Fund for Research into Crippling Diseases.

Rixson, D. C. (2000) *The History of Meat Trading*. London, Nottingham University Press.

Roberts, G. K. (1989) Electrification. *In*: C. Chant, (ed) *Science, technology and everyday life, 1870-1950*. London & New York, Routledge in association with the Open University. pp. 68-112.

Robinson, L. M. (1999) Safeguarded by Your Refrigerator: Mary Engle Pennington's struggle with the National Association of Ice Industries. *In*: S. Stage & V. B. Vincenti (eds) *Rethinking Home Economics: Women and the History of a Profession*. Ithaca & London, Cornell University Press.

Rose, G. (2003) Family photographs and domestic spacings: a case study. *Transactions of the Institute of British Geographers*, NS 28, 5-18.

Rowland, F. S. & Molina, M. J. (1975) Chlorofluoromethanes in the environment. *Reviews of Geophysics and Space Physics*, 13, 1-35.

Rowland, F. S. (1995) *Nobel Lecture in Chemistry, December 8, 1995*. http://nobelprize.org/nobel_prizes/chemistry/laureates/1995/rowland-lecture.pdf

Rowland, F. S. (1997) Change of atmosphere. *Our Planet: The magazine of the United Nations Environment Programme*, 9(2), October, http://www.ourplanet.com/imgversn/92/rowland.html

Rybczynski, W. (1986) Home: a short history of an idea. Harmondsworth, Penguin.

Sammond, N. (1990) The world turned upside down. *Exploratorium Quarterly*, Fall 1990, 14(3), 30-34.

Sapsted, D. (2003) 70,000 unwanted fridges await countryside crusher. The Telegraph, February 2nd, http://www.telegraph.co.uk/news/main.jhtml;sessionid=SXZPYJGMTYLPFQFIQMFCM54AVCBQYJVC?xml=/news/2003/02/08/nfrid08.xml

Saussure, F. de [1916] (1974) *Course in General Linguistics*. Translated by W. Baskin. London, Fontana/Collins.

Sayres, E. A. (1928) Using heat to make ice. *The Home Economist*, 6(10), 284-285, 302.

Schaffer, S. (2000) Mission Statement. *Journal of Mundane Behavior*. http://www.mundanebehavior.org/index2.htm

Schatzki, T., Knorr Cetina, K. & von Savigny, E. (eds) (2001) *The practice turn in contemporary theory*. London, Routledge. pp. 163-74.

Scientific American (1857) Transporting Project. *Scientific American*, XIII, November 7th, p. 70.

Scott, G. (2003) *Homes fit for housewives? The Woman's Co-operative Guild and housing policy in post-war Britain*. Conference paper, Design History Society Conference, Norwich 2003.

Scott, P. (1934) *An Electrical Adventure*. London

Secord, J. A. (2004) Knowledge in Transit. Halifax Keynote Address. *Isis*, 95, 654-672.

Shachtman, T. (1999) *Absolute Zero and the Conquest of Cold*. Boston & New York, Mariner Books.

Shapin, S. & Schaffer, S. (1985) *Leviathan and the Air Pump: Hobbes, Boyle and the experimental life.* Princeton, NJ, Princeton University Press.

Sheldon, J. & Kurti, N. (1975) Freezing technology in the market place [and discussion]. *Proceedings of the Royal Society of London. Series B, Biological Sciences*, 191(1102), 111-129.

Shove, E. & Pantzar, M. (2007) Recruitment and Reproduction: The Careers and Carriers of Digital Photography and Floorball. *Human Affairs*, 2, 154-167.

Shove, E. & Southerton, D. (2000) Defrosting the Freezer: From Novelty to Convenience – A Narrative of Normalization. *Journal of Material Culture*, 5(3), 301-19.

Shove, E. (2002) *Sustainability, system innovation and the laundry*. Online publications, Department of Sociology, Lancaster University.

Sigsworth, E. M. (1965) Science and the Brewing Industry, 1850-1900. *The Economic History Review*, 17(3), 536-550.

Silva, E. (1999) Transforming Housewifery: Dispositions, Practices and Technologies. *In*: E. Silva & C. Smart (eds) *The New Family?* London, Thousand Oaks.

Silva, E. B. (2000) The cook, the cooker and the gendering of technology. *The Sociological Review*, 48(4), 612-628.

Silverstone, R. & Haddon, L. (1996) Design and the domestication of information and communications technologies: technical change and everyday life. *In*: R. Mansell & R. Silverstone (eds) *Communication by Design: the politics of communication technologies*. Oxford, Oxford University Press. pp. 44-74.

Silverstone, R. & Hirsch, E. (eds) (1992) *Consuming Technologies: media and information in domestic spaces*. London & New York, Routledge.

Silverstone, R. (1994) *Television and Everyday Life*. London, Routledge.

Simpson, H. (n.d., c. 1930s) *The Electric Refrigeration Home Handbook*. London, British Electrical Development Association.

Smith, P. C. F. (1962) *Crystal Blocks of Yankee Coldness: The Development of the Massachusetts Ice Trade from Frederick Tudor to Wenham Lake*. Wenham, MA, Wenham Historical Association and Museum.

Snow, J. (1855) *On the Mode of Communication of Cholera*. London, John Churchill.

Sofia, Z. (2000) Container technologies. *Hypatia*, 15(2), 181-201.

Solomon, S. (1990) Progress towards a quantitative understanding of Antarctic ozone depletion. *Nature*, 347, 347-354.

Solomon, S., Garcia, R. R., Rowland, F. S. & Wuebbles D. J. (1986) On the Depletion of Antarctic Ozone. *Nature*, 321, 755-8.

South Wales Argus (2001) AM turns up heat in fridge row. *The South Wales Argus*, December 27th, http://archive.southwalesargus.co.uk/2001/12/27/74891.html

Southerton, D. (2003) 'Squeezing time': allocating practices, coordinating networks and scheduling society. *Time & Society*, 12(1), 5-25.

Spain, D. (1992) *Gendered Spaces*. Chapel Hill, University of North Carolina Press.

Spriegel, G. (1990) Food safety in the home. *Nutrition & Food Science*, 90(6), 14-15.

Squire, R. (1984) *Portrait of an Architect*. Gerrards Cross, Colin Smythe.

Star, S. L. (1999) The Ethnography of Infrastructure. *American Behavioural Scientist*. 43(3), 377-91.

Strasser, S. (1982) *Never Done: A History of American Housework*. New York, Pantheon.

Strasser, S. (2000) *Waste and Want: A Social History of Trash*. New York, Owl Books.

Straw, W. (1999) The Thingishness of Things. *Invisible Culture: An Electronic Journal for Visual Studies*, 2, https://urresearch.rochester.edu/retrieve/1991/IVC_iss2_Straw.pdf

Sunday Times (1969) Britain breaks the ice and plunges into the deep freezer. *The Sunday Times*, July 27th.

Symons, L. (1993) The Electrical Association for Women, 1924-1986. *Institution of Electrical Engineers Proceedings*, 140, 215-220.

Taubes, G. (2002) Lofty Achievement: NOAA's *Susan Solomon* on Atmospheric Chemistry. Science Watch Interview. *Science Watch*, 13(5), http://www.sciencewatch.com/sept-oct2002/sw_sept-oct2002_page3.htm

Telegraph & Argus (2002) Fridge mountain just grows … and grows. *Telegraph and Argus*, February 9th, http://archive.thetelegraphandargus.co.uk/2002/2/9/130324.html

Terry, J. & Calvert, M. (1997) *Processed Lives: Gender and technology in everyday life*. London & New York, Routledge.

Tesla, N. (1888) A New System of Alternating Current Motors and Transformers. *American Institute of Electrical Engineers*, May 1888.

Thoreau, H. D. (1954) *Walden; or, Life in the Woods*. Boston, Ticknor & Fields.

Third Report of The Commissioners appointed to inquire into The Origin and Nature, etc. of The Cattle Plague (1866) Houses of Parliament, London.

The Times (1822) The confectioners have been able to lay in a store of ice to freeze their creams in summer! *The Times*, January 21st, p. 3.

The Times (1826) The following method of obtaining ice at any season of the year. *The Times*, September 4th, p. 3.

The Times (1944) The New Steel Houses: Lord Portal on costs and materials, House of Lords. *The Times*, May 3rd, p. 8.

The Times (1945) Erection of houses sent from USA: Training operatives. *The Times*, July 9th, p. 2.

Thévenot, R. (1979) *A History of Refrigeration Throughout the World*. Translated by J. C. Fidler. Paris, International Institute of Refrigeration.

Thompson, B. (1798) Heat is a Form of Motion: An Experiment in Boring Cannon. *Philosophical Transactions*, 88.

Thompson, M. (1979) *Rubbish Theory: The creation and destruction of value*. Oxford, Oxford University Press.

Thrift, N. (1985) Flies and Germs: A Geography of Knowledge. *In*: D. Gregory & J. Urry (eds) *Social Relations and Spatial Structures*, Houndsmill, Basingstoke, Hampshire & London: Macmillan. pp. 366-403.

Titus, J. G. (ed) (1986) *Effects of changes in stratospheric ozone and global climate*. Proceedings of the United Nations Environment Programme (UNEP)/Environmental Protection Agency (EPA) International Conference on Health and Environmental Effects of Ozone Modification and Climate Change. Washington DC, US EPA.

Tomes, N. (1998) *The Gospel of Germs: Men, Women and the Microbe in American Life*. Cambridge, MA & London, Harvard University Press.

Traweek, S. (1988) *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge, MA, Harvard University Press.

Tricity (n.d.) *Tricity Instruction Card*. London, Tricity.

Tudor Walters Committee (1918) *Report of the Committee to consider questions of building construction in connection with the provision of dwellings for the working classes in England and Wales, and Scotland*. London, HMSO.

UNEP (1985) *The Vienna Convention for the Protection of the Ozone Layer*. Vienna, Austria, UNEP.

UNEP (1987) *Montreal Protocol on Substances that Deplete the Ozone Layer, Final Act.* Montreal, Canada, UNEP.

United States Department of State (1890) *Refrigerators and Food Preservation in Foreign Countries*. Special Consular Reports, Reports from the consuls of the United States on the use of refrigerators and natural and manufactured ice for the preservation of food in their several districts in answer to a circular from the Department of State. Washington, Government Printing Office.

Vale, B. (1995) *Prefabs: A History of the UK Temporary Housing Programme*. London, E & FN Spon.

VanEvery, J. (1997) Understanding Gendered Inequality: Reconceptualizing Housework. *Women's Studies International Forum*, 20(3), 411-420.

Verbeek, P. (2004) *What Things Do: Philosophical Reflections on Technology, Agency and Design*. University Park, Pennsylvania State University Press.

Volti, R. (1994) How we got Frozen Food. *Invention and Technology Magazine*, 9(4), http://www.americanheritage.com/articles/magazine/it/1994/4/1994_4_46.shtml

Vrooman, F. B. (1895) Public Health and National Defense. *The Arena*, 69, 425-438.

Wajcman, J. (1991) *Feminism Confronts Technology*. Cambridge, Polity Press.

Walker, A. (1996) *Food Safety in the Home.* A Report on Office of National Statistics Omnibus Survey Data produced on behalf of the Department of Health. London, HMSO.

Warde, A. (2005) Consumption and Theories of Practice. *Journal of Consumer Culture*, 5(2), 131-153.

Ware, M. S. (1963-4) Refrigeration for Frozen Foods in the Retail Trade. *Proceedings of the Institue of Refrigeration*, 60, 175-193.

Watkins, H. (2006) Beauty Queen, Bulletin Board and Browser: Rescripting the refrigerator. *Gender, Place and Culture*, 13(2), 143-152.

Watson, R. T., Gelle, M. A., Stolarski, R. S. & Hampson, R. F. (1986) *Present state of knowledge of the upper atmosphere: An assessment report; processes that control ozone and other climatically important trace gases*. Washington DC, NASA.

Weale, S. (2002) The great sell-by con. *The Guardian*, 7th November, http://www.guardian.co.uk/food/Story/0,2763,835041,00.html

Weaver, R. & Dale, R. (1992) *Machines in the Home*. London, The British Library.

Webb, J. (1969) *Address for press luncheon on food freezing*. September 1969. Typed sheet, Jenny Webb's personal papers.

Webb, J. (1984) *Treatment of food affected by extended freezer breakdowns*. Typed sheet, Jenny Webb's personal papers.

Webb, J. (2003) *Food from the Fridge*. Unpublished manuscript.

Weightman, G. (2001) *The Frozen Water Trade: How ice from New England lakes kept the world cool*. London, Harper Collins.

Welsh Office Department of the Environment & Scottish Office Environment Department (1994) *Environmental Protection Act 1990: Part II Waste Management Liscencing. The Framework Directive on Waste*. Joint Circular. Cardiff & Edinburgh, Welsh Office & Scottish Office.

WGPW (Women's Group on Public Welfare subcommittee on Scientific Management in the Home) (1950) *Report of an enquiry into the effect of the design of the temporary prefabricated bungalow on household routines*. London, The Women's Group on Public Welfare.

Which? (1987) "They don't make them like that any more …" *Which?* October 1987.

White, R. B. (1965) *Prefabrication: A history of its development in Great Britain*. National Building Studies Special Report 36, Ministry of Technology Building Research Station. London, HMSO.

Whitteker, L. (2002) *Entrepreneurs: Thomas Brydone & William Soltau Davidson*, http://www.nzedge.com/heroes/brydonedavidson.html

Williams, A. (2003a) *Fridge mountains – What went wrong?* The Centre for Business Relationships, Accountability, Sustainability and Society (BRASS) comment and analysis piece. http://www.brass.cf.ac.uk/uploads/cafridgemountainAW0203.pdf

Williams, A. (2003b) *Governance and Sustainability: An Investigation of the Role of Policy Mediators in the European Union Policy Process*. BRASS Working Paper Series No. 2. Cardiff, BRASS.

Williams, B. O. (1962) *Your Refrigerator*, *with pictures*. London & Glasgow, Collins.

Williams, J. C. (1998) Getting Housewives the Electric Message: gender and energy marketing in the early twentieth century. *In*: R. Horowitz & A. Hohum (eds) *His and Hers: Gender, Consumption and Technology*. Charlottesville and London, University Press of Virginia. pp. 95-113.

WMO (1986) *Atmospheric Ozone 1985: An assessment of our understanding of the processes controlling its present distribution and change*. World Meteorological Organization Global Ozone Research and Monitoring Project, Report No. 16. Geneva, Switzerland, WMO.

WMO (1988) *Report of the International Ozone Trends Panel – 1988.*World Meteorological Organization Global Ozone Research and Monitoring Project, Report No. 18. Geneva, Switzerland, WMO.

WMO (1992) *Scientific assessment of ozone depletion: 1991*. World Meteorological Organization Global Ozone Research and Monitoring Project, Report No. 25. Geneva, Switzerland, WMO.

Wood, D. & Beck, R. J. (1994) *Home Rules*. Baltimore & London, The Johns Hopkins University Press.

Woolgar, S. (1991) Configuring the user: the case of usability trials. *In*: J. Law (ed) *A Sociology of Monsters: essays on power, technology and domination*. London & New York, Routledge. pp. 57–99.

Woolrich, W. R. (1967) *The men who created cold; a history of refrigeration*. New York, Exposition Press.

Wynter, A. (1854) The London Commissariat. *Quarterly Review*, XCV(VIII), 287.

Young, I. M. (1997) *Intersecting Voices: Dilemmas of gender, political philosophy and policy*. Princeton, Princeton University Press.

Zerubavel, E. (1997) *Social Mindscapes: An Invitation to Cognitive Sociology*. Cambridge, MA, Harvard University Press.

Zimmerman, W. D. (1962) Live Cattle Export Trade Between United States and Great Britain, 1868-1885, *Agricultural History*, 36, 46-52.

APPENDIX A

Interview Participants

Household interviews

Name	Age	Marital status	Dependent Children (Adult Children)	Occupation	Location	Date & place of interview	Housing tenure
Abigail Rowles	30s	Married	3	Doctor	London	16/6/03 at home	own
Betty Wood	80s	Widowed	(1)	Retired cleaner	Norfolk	20/5/03 at home	rent (local authority)
Carrie & Keith Anderson	40s 50s	Married	1 + (4)	Radiographer & Self-sufficient gardener	Norfolk	27/5/03 at home	own
Dorothy Ladd	70s	Widowed	(2)	Retired Secretary	London	19/9/02 & 20/6/03 at home	own
Efia Boateng	30s	Married	2	Computer Technician	London	14/6/03 at home	own
Frank Paxton & Claire Ashley	30s 20s	living with partner	2	Environmental Educator Full-time Mother	Swansea	11/6/03 at home	rent (private)
Fred & Marianne Emery	70s 60s	Married	(2)	Retired reporter/TV presenter	London	17/10/02 at home	own
Geoff & Nancy Bauer	80s 70s	Married	(1)	Retired RAF Officer	Norfolk	18/5/03 at home	own
Grace & Peter Templeton	60s 60s	Married	(2)	Artist & Judge	Norfolk	19/5/03 at home	own
Gwen Wiseman	70s	Married	(1)	Retired Housekeeper	London	18/10/02 Blackheath Reminiscence Centre	own
Iris O'Neill	70s	married	(2)	Retired Sales Assistant	London	18/10/02 Blackheath Reminiscence Centre	own

Name	Age	Marital status	Dependent children (Adult children)	Occupation	Location	Date & place of interview	Housing tenure
Janet Cooper	60s	Married	(2)	Administrator	Hereford	20/6/03 Telephone interview	own
Jenny Webb	60s	Widowed	0	Home Economist	London	21/6/03 at home	own
Jonathan & Doreen Knight	60s	Married	0	Sales Manager & Clerical Officer	Norfolk	29/5/03 at home	own
Lisa Cooper	30s	Single	0	Scientist	London	14/6/03 at home	own
Maggie Marsh	40s	married	(1)	College Lecturer	Swansea	11/6/03 at home	own
Michelle Wilson	50s	single	0	Community Support Worker	Swansea	12/6/03 at home	own
Ronnie Porter	70s	widowed	(2)	Retired Railway Signalman	Norfolk	29/5/03 at home	rent (local authority)
Ruth Hägen	50s	married	1 + (2)	University Lecturer	Oxford	24/10/02 at home	own
Donna Mitchel & Steph Jacobs	40s 50s	living with partner	0	Social Worker Civil Servant	Norfolk	30/5/03 at home	own
Seema & Hamid Bashir	40s 40s	married	0	Officer in Pakistan Air Force	London	16/6/03 at home	military housing
Tony Hawks	40s	single	0	Comedian/writer/Presenter	London	17/6/02 at a café	own

Workplace interviews

Name	Position	Organisation	Place of interview	Date of interview
Ian Staunton	Waste Manager	Greenwich Council	Greenwich Council Waste Transfer Station	25/9/02
Henry Drake	Chair	Respond	Respond's warehouse	16/10/02
Shaun Carter	Business Development Manager	Respond	Respond's warehouse	16/10/02
Rod & Jacko	Collection team	Respond	Out in the van on a collection round	22/10/02
Doug Mansley	Appliance repairman	Respond	Respond's workshop	22/10/02
Tim Hunkin	Engineer, cartoonist and exhibition designer	Self-employed	At home, Suffolk	27/10/02
Alan Cooper	Chartered Engineer, Refrigeration Engineering Consultant	Cooper Enterprises	Paddington Station	31/10/02
Brian Williams	Technical Product Manager	LG Electronics	LG's offices, Slough	6/11/02
Jason Arlington	Technician	Science Museum	Science Museum's Large Object Store, Wroughton	7/11/02
Andrew Ellis	Curator	Science Museum	London	8/11/02
Thomas Driver	Head of Collections	Science Museum	London	8/11/02
Mike McFadyen	Electrical engineer	Self-employed	At home, Norfolk	16/5/03
Carl Aspin	Manager, Fridge Recycling Plant	European Metal Recycling	EMR, Willesden	17/6/03
Jenny Webb	Retired – former Appliance Demonstrator and Home Economist	London Electricity Board Electricity Council	At home, London	21/6/03

APPENDIX B

<u>Oral Histories, British Library Sound Archive</u>

Name	Source	Born	Marital Status	Children	Occupation	Father's & Mother's Occupations	Interviewed/ recorded by	Date and place
Alice Pountney	MMB	1910	widowed	2	Retired Domestic Servant	Glass cutter Housewife	Helen Lloyd Radio WM	25/2/99 at home
David Abbott	MMB	1959	Married	2	Traffic Engineer	Factory worker Engineering	Jo Hollis Radio Leicester	1/2/99 at home
Dennis Barber	MMB	1940	divorced	2	Retired RAF	Engineer for Bentley Hosiery homeworker	Jo Hollis Radio Leicester	29/1/99 at home
Elsie Olivey	MMB	1921	widowed	0	Retired School Secretary	Miner Housewife	Andy Vivian Radio Gloucestershire	11/12/98 at home
Florence Wadlow	MMB	1912	widowed	2	Retired Cook in Service	Fish Porter at Billingsgate Market Cook in Service	Alison Turpin Radio Norfolk	2/2/99 at home
Frances Soar	MMB	1952	living with partner	0	Senior Administrator, Geographical Association	Businessman Housewife	Clare Jenkins Radio Sheffield	16/2/99 at work
Hugh Price Jones	MMB	1910	widowed	2	Retired Architect & Builder	Grocer not specified	Chris Eldon Lee Radio Shropshire	15/3/99 at home
June Care	MMB	1947	married	2	Home Economist	Manager of wholesale meat suppliers Housewife	Joanne Curtis Radio Kent	8/3/99 at home
Lois Carnie	MMB	1962	married	3	Clinical Dietician	Church minister Teacher	Simon Evans Radio Kent	26/4/99 at work
Mary Forster	MMB	1923	married	4	Retired Shop Assistant	Glass blower Housewife	Virtue Jones Radio Newcastle	1/2/99 at home
Mary Trett	MMB	1926	single	0	Retired Art Teacher	Builder and undertaker Housewife	Alison Turpin Radio Norfolk	3/2/99 at home
Norm~~o~~n Robson	FFSS	1922	married	2	Food Technologist	Accountant Housewife	Polly Russell	4/3/04, 27/4/04, 27/5/04
Peter Jacomelli	FFSS	1917	married	1	Restaurateur	Restaurateur Restaurateur	Polly Russell	6/00 at home

APPENDIX C

Interview Guide

I conducted semi-structured interviews and used the following questions as a starting point for broader discussions, whilst ensuring that we touched on all these areas over the course of the conversation. All participants signed consent forms (see Appendix D for Certificate of Approval).

- Where is your fridge located? Do you have more than one fridge in your household? If so, where are the others and what are they used for?
- Do you have a freezer? Is it separate or combined with your fridge?
- How long have you had your current fridge?
- Where did you get it from?
- Did you choose it? If so, why?
- Who in your household makes greatest use of the fridge?
- Do members of your household tend to eat together or separately?
- Does one individual have sole/primary responsibility for cooking and shopping or are these tasks shared? How does this situation compare to the household in which you grew up?
- Where and how often do you do your grocery shopping?
- How have your shopping habits changed over time?
- Do you have, or would you consider having, groceries delivered?
- Who is usually responsible for stocking and organising the fridge?
- How do you organise space and manage food storage in your kitchen?
- Do you always store particular things in particular parts of the fridge? If so, why?
- Are different parts of the fridge used in different ways by different household members?
- How often is the fridge cleared out and/or cleaned? Who is responsible for doing this?
- Does your fridge require defrosting? If so, how often is this done?
- Do you keep track of storage times in the fridge and freezer? How do you decide whether items are still good to use?

- Are there disagreements in your household about where, how or how long to store foods?
- Were you aware of 'learning' to use a fridge? If so how, when and from whom?
- Has your fridge use changed over time? In what ways?
- Did you have a fridge in your childhood home? How was food stored prior to having a fridge? What are your earliest fridge memories?
- Do you understand how your fridge works?
- Have you ever had it repaired or attempted to repair it yourself?
- What would make you decide to replace your fridge? What would you look for in a new/replacement fridge? How important are factors such as size, style, price, colour, energy use, special features etc?
- What would you do with your old fridge?
- Are you aware of the regulations for disposing of refrigerators?
- Would you be able to manage without a fridge and/or other household appliances? How important is the fridge compared to other technologies in your home?
- How much time do household members tend to spend in the kitchen? What activities take place there?
- Do you use the fridge for purposes other than storing food? If so, what?
- Do you decorate the fridge and stick messages and/or magnets on it?
- How do you feel about other people looking in your fridge? What do you think someone might learn about you from doing so?
- How typical or atypical do you think your fridge use is in relation to your family and friends, or compared to media representations?
- Have you heard of/seen/used the new generation of 'smart' appliances? Would you be interested in having a web-enabled fridge or other household appliance? What advantages or disadvantages do you think it would offer?
- If you could alter or improve any aspect of your fridge what would it be?

APPENDIX D

Certificate of Approval to Conduct Research with Human Subjects

The University of British Columbia
Office of Research Services and Administration
Behavioural Research Ethics Board

Certificate of Approval

PRINCIPAL INVESTIGATOR	DEPARTMENT	NUMBER
Gregory, D.J.	Geography	**B02-0336**

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT

CO-INVESTIGATORS:
Watkins, Helen, Geography

SPONSORING AGENCIES
Internal UBC Grant

TITLE :
Fridge Space: Cultural geographies of the domestic refrigerator

APPROVAL DATE	TERM (YEARS)	DOCUMENTS INCLUDED IN THIS APPROVAL:
AUG 30 2002	1	30 July 2002, consent form

CERTIFICATION:

The protocol describing the above-named project has been reviewed by the Committee and the experimental procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval of the Behavioural Research Ethics Board by:
Dr. James Frankish, Chair

This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures