Making WiFi:

A Sociological Study of Backyard Technologists in Suburban Australia

Katrina Jungnickel

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INCITE (Incubator for Critical Inquiry into Technology and Ethnography)
Department of Sociology
Goldsmiths
University of London
New Cross, London SE14 6NW

The work presented in the thesis is the candidate's own.

Katrina Elly Jungnickel

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Abstract.

This thesis explores the culture of new digital technology - Wireless Fidelity (WiFi). Drawing on an ethnography of the largest not-for-profit community WiFi group in Australia, it examines how members construct a communications network that spans across the largely suburban city of Adelaide by connecting together home-made antennas, many of which are located in their own backyards. I show how these individuals, whom I term *backyard technologists,* collectively make WiFi using a diverse range of materials and improvised methods in places and at times outside conventional information communication technology (ICT) innovation contexts. They imbue a Do-It-Yourself (DIY) ethic yet importantly they do not do it alone – they Do-It-Together (DIT).

My study begins by examining the role and importance of representations established in science and technology studies (STS), particularly in the work of Latour and Woolgar (1979) and Henderson (1999). In these contexts, objects and methods of rendering are linked to particular ways of seeing the world: the production of graphs, diagrams and images are seen as pivotal to understanding how practitioners collaborate, construct knowledge and recruit allies. Central to this literature is the idea of stable, rigorously ordered and immutable public 'facts' that reduce, or entirely erase ambiguity and alternative interpretation. Foregrounding the many representations WiFi members make, I describe how regular encounters with trees, thieves, birds, possums, neighbours, technical complications, a myriad of materials and the weather are implicated in the daily practice of making WiFi. Rather than filtering out and tidying up daily interruptions, I show how members build them into their network. My analysis reveals the public exposure of the messy *middlework* of making WiFi and I explain that this practice is not a consequence of a fragile technology, the elastic nature of the group or an unpredictable environment but rather deliberately produced, critical to how they innovate, expand the network and recruit new members. Drawing on Actor Network Theory (ANT), I argue that the current understanding of representations in STS does not account for an expanded typology, that is, the possibility of multi-dimensional co-located contingent assemblies of knowledge. Moreover, attending to the nuances and textures of this *homebrew high-tech* network, this thesis establishes the presence of a distinct version of WiFi - an Australian WiFi - thus contributing to the study of different versions of ICTs (Miller and Slater 2000; Goggin 2004; 2007; Ito et al 2005). It concludes by proposing alternate means of representing mess in STS and more broadly in the craft of sociology.

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While a doctorate can at times feel like an extremely lonely pursuit, I was never ever alone. Now, in its final form, this document veritably hums with the collaborative energy of a community of people who have contributed, participated and shaped my writing. Here, I take the opportunity to say a very heartfelt thankyou.

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Contents.

List of figures 8

Glossary 10

Chapter One **Who else makes WiFi?** 11

What is WiFi and why is it interesting?
Air-Stream – An Australian community WiFi network
The importance of studying marginal and mundane technologies
Key themes and questions
Overview of chapters

Chapter Two **Studying science, technology and representational culture in suburban Australia** 26

A review of existing WiFi literature
Guiding themes
I. The nature of technological connectivity in Australia

II. The visual culture of technology infrastructure
- The paradox of the DIY visual infrastructure
- Visual culture in the development of ICTs
- STS approaches to visual culture
- Approaching WiFi through Actor Network Theory (ANT)

III The Australian cultural context and practices
- Locating 'real' Australia in the 'vast and unexplored suburban tundra'
- Suburban Australian backyards and shed culture
- Does Australian WiFi 'stick' to Australian men?

Conclusion

Chapter Three **Researching Australian backyard technologists** 58

Suburban Adelaide
Who's who in Air-Stream's WiFi network
Practical epistemologies – Ways of seeing and knowing visual culture
Multi-sited ethnography
Moving between multi-sited fields
Participation and observation
Visual and textual field notes
Mess and the potential for new expression
Conclusion

Chapter Four **Disorderly design** 87

In the quadrangle, at a 'barbie'
- Connecting people together
- Transactions and interactions
- Recruiting people
- The barbeque and WiFi?

In the computer room, at a meeting
- Designing for accidental discovery
- The 'myth' of order
- Abandoning control

Air-Stream WiFi and productions of masculinity
Conclusion

Chapter Five **Representing interruption** 113

The co-existence of stability *and* instability
- The problematic and productive presence of trees
- The sun and sunburnt technology
- Bugs, birds and 'gully wind'
- A 'cocktail' of technical problems
- Family involvement
- Moving house, moving antennas
- Volunteers, time and skills

Building interruption into the system
Conclusion

Chapter Six **Mods, middlework and making-do** 140

Making *middlework* public
- Making the network, not just consuming it
- Barbeques, sheds, families and other contingencies
- Bricolage - conversing with materials 'at hand'
- The thrill of making things fit
- Modding and mods – Australian middlework?

'Making-do' - an Australian approach to inventiveness
Conclusion

Chapter Seven **Stumbling in digital suburbia** 170

Visualising 'wireless noise'
- Defining stumbling
- Defining noise

The mundane everydayness of stumbling
Reconfiguring suburbia
Landscapes of possibility
Inscribing hope, chance and possibility
Building a collaborative technology
Conclusion – A 'feral' infrastructure

Chapter Eight **Homebrew high-tech** 199

Dodgy DIYers or innovative problem solvers?
Stickytape technology
The place of tinkering in homebrew high-tech
Building reputation
Makeaholics and shopaholics
Backyard technology in a commercial world
Conclusion

Chapter Nine **Conclusion** 218

Taking apart the stable notion of connectivity
A multi-dimensional culture of connectivity
Messiness as a way of explaining Air-Stream's backyard technologists
The Australian cultural context – Towards an Australian WiFi
The productive possibility of mess in sociology
Making *middlework* public

References 236

List of figures.

Fig. 1 Map showing in detail the location of Adelaide in South Australia (Personal image).

Fig. 2. *Telstra's* web advertisement for its *BigPond Wireless Broadband* service (Accessed 04.10.07, Available at: http://www.beeneverywhere.com.au/html/index.htm).

Fig. 3. A selection of images illustrating how WiFi is represented (Various, see page 32).

Fig. 4. Map showing the population density of Australia (ABS 2008).

Fig. 5. The network node map (Distributed at an Air-Stream meeting 16.09.07).

Fig. 6. Images illustrating how I learnt to build and ride 'freakbikes' (Personal images 2006-2007).

Fig.7. My project described on the Air-Stream website (Accessed 30.07.06, Available at: http://www.air-stream.org.au/Katrina).

Fig. 8. My research blog described on the Air-Stream website (Accessed 20.08.06, Available at: http://www.air-stream.org.au/makingwifi).

Fig. 9. My leaving the group described on the Air-Stream website (Accessed 30.03.07, Available at: http://www.air-stream.org.au/search/node/farewell).

Fig. 10. Some of my ethnographic sketches I posted to the Air-Stream website (Accessed 30.01.07, Available at: http://www.air-stream.org.au/node/915).

Fig. 11. I'm still connected to the group – One of my sketches in use on the Air-Stream website (Accessed 4.12.08, Available at: http://www.air-stream.org.au/wireless_meeting).

Fig.12. A screengrab from my research blog - Making WiFi (Accessed 30.07.06, Available at: www.studioincite.com/MakingWiFi)

Fig. 13. Photos of various 'barbies' held in the school quadrangle (Personal images 2006-2007).

Fig. 14. Agenda for a monthly meeting posted on the group's website (Accessed 31.01.07, Available at: http://www.air-stream.org.au/meeting31012007).

Fig. 15. John shows photos of equipment for sale (Personal image 29.11.06).

Fig. 16. Close up of the Air-Stream NWO logo (Personal image 29.11.06).

Fig. 17. The merchandise table at the 'barbie' (Personal image 29.11.06).

Fig. 18. The 'social framework' of Air-Stream's 'barbies' (Personal image 29.11.06).

Fig. 19. Tim overwrites on the white board (Personal image 28.01.07).

Fig. 20. Tim 'demo's' on the whiteboard, the projected screen and on laptops (28.01.07).

Fig. 21. Turning out the lights to see the projection in more detail (Personal image 28.01.07).

Fig. 22. Diagram of how line of sight (LOS) operates in a WiFi network (Accessed 10.10.06, Available at: http://www.air-stream.org.au/los).

Fig. 23. Signs in city streets alerting locals to presence of wildlife (Personal images 12.08.07).

Fig. 24. Air-Stream Open Day poster (Accessed 09.04.06, Available at: http://www.air-stream.org.au/od4/program).

Fig. 25. Comparison of *Ile Sans Fil* network map of individual 'hotspots' in Montreal, Cana (Accessed 10.06.07, Available at:http://montrealtechwatch.com) and Air-Stream's network node map (Distributed at an Air-Stream meeting 16.09.06).

Fig. 26. An updated map distributed at an Air-Stream meeting (Personal image 28.02.07).

Fig. 27. A selection of Air-Stream network node maps (Sept 2006, Feb & June 2007, Feb 2008).

Fig. 28. Peter and Craig 'update' the group using photos on a screen (Personal image 26.07.6).

Fig. 29. A description of membership on the Air-Stream website (Accessed 10.06.06, Available at: http://www.air-stream.org.au/membership).

Fig. 30. A retouched photo of a 'snag' skewered on a WiFi mast, published on the Air-Stream website (Accessed 12.10.06, Available at: http://www.air-stream.org.au/northfield).

Fig. 31. Cooking 'skippy' on the barbie before raising an antenna (Personal image 13.11.06).

Fig. 32. Dave works on his antenna in the backyard (Personal image 13.11.06).

Fig. 33. Inside and outside the biscuit tin node box (Personal images 13.11.06).

Fig. 34. Building a node is a collaborative process (Personal images 13.11.06).

Fig. 35. Raising the antenna on Dave's backyard shed (Personal image 13.11.06).

Fig. 36. A webpost published by Dave on the Air-Stream website (Accessed 10.01.07, Available at: http://www.air-stream.org.au/athelstone).

Fig. 37. Stumbling for wireless 'noise' in a suburban yard (Personal image 19.11.06).

Fig. 38. Simon demo's a stumbling rig at a meeting (Personal image 28.02.07).

Fig. 39. Screengrabs from NetStumbler on the Air-Stream website (Accessed 15.06.08, Available at: http://www.air-stream.org.au/stumbling_rig).9.11.06).

Fig. 40. Unpacking the stumbling rig from the van (19.11.06)

Fig. 41. Setting up on the lawn (Personal image 19.11.06).

Fig. 42. Close up of Ben's home-made cantenna (Personal image 19.11.06).

Fig. 43. Three antennas; broken dish, cantenna and car antenna (Personal images 19.11.06).

Fig. 44. We 'go higher', onto the roof (Personal images 19.11.06).

Fig. 45. Ben balances on the peak of the suburban rooftop (Personal image 19.11.06).

Fig. 46. Ben stumbles with different antennas on the rooftop (Personal images 19.11.06).

Fig. 47. Results from the stumble (Personal images 19.11.06).

Fig. 48. Review of commercial equipment on the Air-Stream website (Accessed 3.03.08, Available at: (http://www.air-stream.org.au/wrt300n_review).

Fig. 49. A single photo versus a join-up (personal images).

Fig. 50. A 'homebrew' exhibition of my PhD research (Personal images 20.01.07).

Glossary.

ACMA	Australian Communications and Media Authority
ADSL	Asymmetric Digital Subscriber Line
ANT	Actor Network Theory
AP	Access Point, also known as node or antenna
BBQ	Barbeque or 'barbie'
DIY	Do It Yourself
DIT	Do It Together
DNS	Domain Name System
FTP	File Transfer Protocol
IBYS	Institute of Backyard Studies
ICT	Information Communication Technology
IM	Instant Messenger
IP	Internet Protocol
IRC	Internet Relay Chat
ISP	Independent Service Provider
Kbs	Kilobytes per second
LAN	Local Area Network
LOS	Line Of Sight
Mbps	Megabytes per second
MP3	Audio layer three, a digital audio encoding format
OSS	Open Source Software
SMS	Short Message Service
STS	Science and Technology Studies
VoIP	Voice Over Internet Protocol
WLAN	Wireless Local Area Network
WiFi	Wireless Fidelity
Wiki	What I Know, collaborative editing OSS software
WiMAX	Wireless Microwave Access
WLAN	Wireless Local Area Network

Chapter One.

Who else makes WiFi?

On the 17th March 2006, a major node [antenna] in Adelaide's Air-Stream Wireless not-for-profit community network was stolen from the top of a factory in the southeast of the city. At a cost of AUS$5000 [GBP£2000], it was not cheap and it is not the first time it has happened to the group. Equipment has been stolen from five different sites with three thefts so far this year.

The first, in June 2005, was on the roof of a large supermarket. Someone cut through the base of the four-metre steel mast to remove two dishes. Then, in February 2006, a wireless box went missing from the roof of a residential house. The owners were away when it was taken and it was only when Dan, a member of the group, failed to connect to the wireless network and went to check the site that he reported it stolen. Two more thefts occurred in March. A node on top of a factory roof was stolen and a week later someone cut the cables and removed the mast from the backyard of a member's home.

Tim and Ron are worried about this emerging pattern. They think thieves might be using the many maps, photos and diagrams on their website to locate sites and plan their attacks. The website is currently open to the public, to encourage new members. Without this information members would not know where the network was located. With it, there is a chance, and increasing reality, that others might use it to locate and steal equipment.

Tim spent last night (Saturday) on the factory roof attempting to set up night vision cameras, but it became too dark, windy and dangerous to continue. Overnight he developed a unique monitoring system, involving his mobile phone, two computers and some quick programming, which will send him a mobile text message if the connection is broken again. He will then race down to the site. He acknowledges it is only a temporary solution. There are many problems with it including the fact he gets a text every time a bird sits on the node (Field notes 19.03.06).

This account comes from an initial meeting I had with Tim, the chairman, and Ron, the treasurer, of *Air-Stream Wireless* (from now on called Air-Stream), the largest community wireless network in Australia. It describes how Air-Stream lost five of the twenty-two major nodes that make up the core infrastructure of its not-for-profit WiFi network spanning the suburban city of Adelaide, the capital of South Australia (Fig. 1). Equipment, in the form of antennas, masts and digital boxes, was forcibly disconnected and taken from the roofs of private houses, commercial factories and large supermarkets. For some members, the theft disconnected them from gaming, file sharing and emailing activities. For others it catalysed a spate of late night innovative rooftop problem solving. As an introduction to the group, this field note provides a tantalising glimpse into some of the many locations, activities and responsibilities involved in making a wireless network. It also highlights the official and unofficial use of the materials made by members. What is clear is that Air-Stream is a group who not only use WiFi, but also make it and fix it when something goes wrong.

These incidents of equipment theft, enabled by the many publicly available maps, photos and diagrams, which are the norm for this not-for-profit community wireless group, illustrate the starting point of my thesis: the role and importance of representations in the development and use of a new digital technology.

The value of representational knowledge has been firmly established in science and technology studies (STS) in science and engineering (Latour and Woolgar 1979; Latour 1987, 1990; Lynch and Woolgar 1990; Henderson 1999; Knorr Cetina 1999; Bucciarelli 2002). In these contexts, graphs, drawings and images are seen as pivotal in understanding how practitioners construct knowledge, design new technologies, organise action and enrol allies. Latour and Woolgar (1979) term these representations of knowledge 'inscriptions' and building on this concept, Henderson's (1999) 'conscriptions' attend to the organising work they do. Despite the significance of this research in gaining an understanding of the socio-technical makeup of new ideas and objects, these studies represent only a fraction of STS literature. Moreover, they primarily attend to 'frontyard' technologists in firmly established authoritative fields of science and engineering or what Star has called 'heroes, big men, important organisations or major projects' (1991:12). Smaller, less triumphal and more mundane 'backyard' technologists, who build artefacts and systems for non commercial use, tend to slip by unnoticed, are trivialised or entirely dismissed. As Thomson, an Australian social historian and director of the Institute of Backyard Studies (IBYS), notes: 'To some, a 'backyard operation' is synonymous with dodgy, low quality, illicit and generally dubious business' (2008:2). Yet, as it has been well argued in STS, technological innovation and knowledge developments also take place outside conventional institutional frameworks (Martin 1994; Latour 1999; de Laet and Mol 2000; Mol 2002; Michael 2000, 2006; Law and Singleton 2005). This study aims to address these gaps by focusing on how a new digital technology, WiFi, is made visible and known by a community not-for-profit wireless network in a suburban Australian city. Just as early STS research brought science '*down to earth*' (Law and Mol 2001:2 emphasis in original), this thesis sets out to examine how a highly sophisticated technology, traditionally shaped and controlled by significant telecommunication organisations, is made for not-for-profit purpose from the ground up, or in this case, from the backyard out.

Given the existing literature on the importance of representations in STS, this thesis sets out to address the following question: Can the representations involved in making WiFi by Australian backyard technologists be considered 'inscriptions' (Latour and Woolgar 1979) or 'conscriptions' (Henderson 1999)? In other words, what is the nature of the visual culture of WiFi made by backyard technologists in suburban Australia? And in what ways does it shape how this new digital technology is designed and used and who can and cannot participate?

What is WiFi and why is it interesting?

WiFi[1] is an electromagnetic radio signal that broadcasts from a broadband modem and provides a way to connect independent computer devices together at points located in a direct line of site (LOS)[2]. It facilitates file sharing, instant messaging (IM), email, voice-over the internet protocol (VoIP) and multi-player gaming. Beyond its technical specifications, WiFi is sociologically interesting for a number of reasons.

Since its launch in 1998, WiFi has achieved widespread popularity primarily as a result of being employed by large-scale telecommunication and Government organisations as a means of wirelessly distributing the internet. In Australia, the end of June 2008 saw a ninety per cent growth in subscriptions of wireless connections, accounting for fourteen per cent of all internet connections (ABS 2008b). Fig. 1, a web advertisement by *Telstra*, Australia's largest telecommunications organisation, is a typical example of the 'anytime', 'everywhere' and 'always on' rhetoric of pay-for-service consumer models that characterise the shift from traditional fixed line computing practises to wireless ones, seemingly unbound by normative time and space. Moreover, because 'wireless' was 'the word' at the annual 2005 Consumer Electronics Show[3] in Las Vegas (Johnson 2005), WiFi enabled mobile phones, laptops, gaming consoles, cameras and even printers have become the norm. Correspondingly, WiFi 'hotspots' where people can connect to a wireless network are found not only in workplaces but in parks, cafes, churches, pubs, trains, planes, airports, surfboards and, apparently, even large stretches of road and beach[4]. However, as indicated in my field note, although popular and widespread, these commercial models do not account for all WiFi infrastructures in operation. There are many others, located on the fringes of established formal institutions, who make WiFi.

Community not-for-profit groups all over the world have been particularly enthusiastic early adopters of WiFi because, unlike other wireless technologies such as mobile phones, it can be designed and shaped for specific local use (Sandvig 2004; MacKenzie 2005). This is made possible because WiFi operates on an unlicensed broadcast spectrum[5], which grants individuals the same rights to broadcast and receive wireless signals as corporate and governmental organisations. In Australia, this is called the 'Public Park Concept' and is relatively unregulated by the Australian Communications and Media Authority (ACMA).

[1] WiFi is a moniker for a series of Wireless Local Area Network (WLAN) 802.11 standards developed by the Institute of Electrical and Electronics Engineers (IEEE).
[2] Dependent on the weather, building materials and strength of the original signal, a single WiFi node or access point (AP), can transmit up to 18 megabytes of data per second (mbps) to a range of five to eight kilometres.
[3] The world's largest exposition and showcase of new consumer electronic technologies and trends.
[4] See BBC 2004b; BBC 2005a; BBC 2005b; Judge 2005; Wired 2005; The Cloud 2006; for a few examples.
[5] WiFi operates on different radio frequencies around the world but they are all publicly open spectrums.

Along with open source software (OSS), which is free to circulate and use without a license fee, WiFi makes it possible to build alternate communication infrastructures that circumnavigate traditional relationships with telecommunication organisations. For the first time individuals can create their own computer networks that are customized to their local environments and avoid the costly charges imposed by independent service providers (ISPs). Often called enthusiasts or hobbyists, these backyard technologists experiment with, build and maintain wireless networks around the demands of salaried employment, family and social commitments in non-conventional contexts such as backyards and bedrooms using a diverse set of found, bought and re-appropriated materials and improvised methods for non-commercial purposes. There are no firm figures for the total number of these groups around the world but estimates suggest there are at least four hundred, with the majority located in Europe (109) and North America (48) (Personal Telco 2008). Australia has fifteen, the largest of which is located in Adelaide, capital of South Australia.

Another reason why WiFi is sociologically interesting relates to the fact that much like science and engineering it is intensely visual. WiFi operates via an invisible radio signal yet it is made visible in a plethora of ways. Axiomatic to commercial and community wireless organisations alike is the presence of a plethora of representations in the form of maps, diagrams, stickers, artefacts, websites, photos and drawings that are fundamentally designed to show people where networks are located and how to use them (Fig. 3).

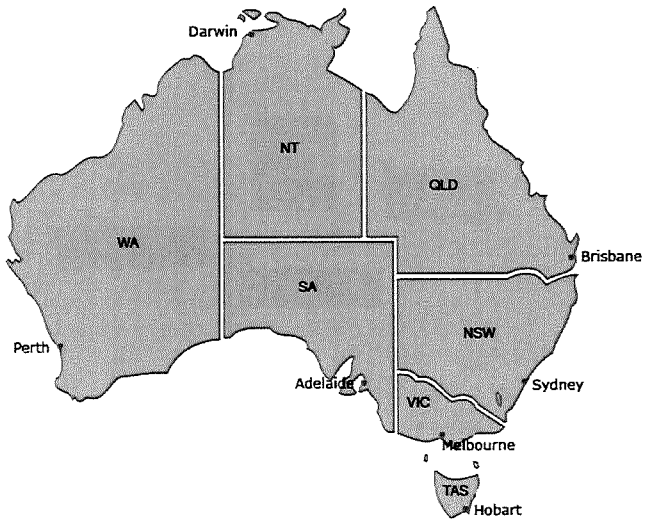

Fig. 1. Map showing in detail the location of Adelaide, the capital of South Australia (SA).

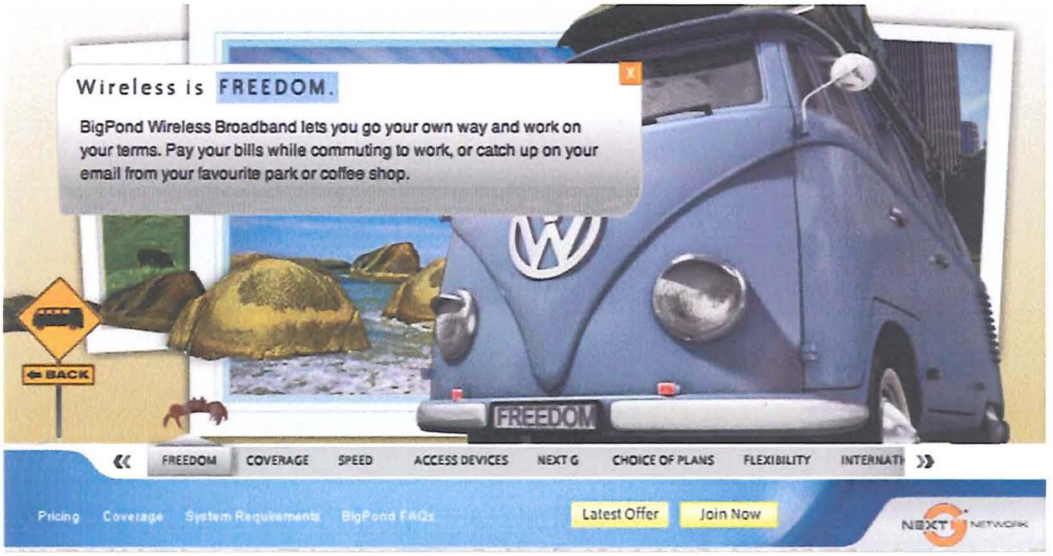

Fig. 2 *Telstra's* web advertisement for its *BigPond Wireless Broadband* service (Accessed 04.10.07, Available at: http://www.beeneverywhere.com.au/html/index.htm).

Fig. 3. L to R: Warchalking symbol indicating an unlocked WiFi hotspot (Ward 2002), Sticker on a Sydney café door advertising a *Telstra* hotspot (Personal image 12.03.06), WiFi hotspot locations in Australia (NodeDB 2006), Air-Stream members installing an antenna (Accessed 10.10.08, Available at: http://www.air-stream.org.au/west_stage_1), Air-Stream node map (distributed at a meeting 16.09.06).

Although there are many organisations that make WiFi, some gain more attention than others. Very rarely, for instance, do representations of community group activities attract national interest. A reason might be related to the way the 'cool aesthetics of wireless advertising combined with the persistent (and persistently misplaced) glamour left over from the dot.com boom still cloud perceptions of wireless as being the domain of the boardroom, the café or the inner-city minimalist apartment' (Goggin and Gregg 2007:45). To compensate for this myopic view, Goggin and Gregg call for research that reflects 'the diversity of vernacular innovations that attend this and every other communication technology Australians have keenly adopted' (ibid). My research responds to this call with the provision of such an alternate view. It also attends to what Bijker has argued about how the 'stories we tell about technology reflect and can also affect our understanding of the place of technology in our lives and our society' (1995:1). Given the loudest stories amplified by westernised media tend to represent the point of view of large ISPs and governmental policy makers, what a study of the culture of community WiFi makers offers is a way of seeing other shapes and uses of this technology in its infancy, rather than accepting how it is already purposed and packaged for a specific use.

Air-Stream – An Australian community WiFi network

This study focuses on Air-Stream, the largest community wireless network in Australia, founded in 2001 by Tim, the chairman, and 'a few mates' (Field notes 07.03.07). At 18 years of age Tim was a keen local area network (LAN) gamer and regularly attended and occasionally hosted LAN parties, where hundreds of enthusiasts would congregate in a school or community hall to connect computers via tangles of ethernet cables, eat pizza and play games. At that time, Australia had very limited IT diffusion. In 2001, only thirty five per cent of households had internet access at home (ABS 2003). Frustrated by the irregular opportunities for group gaming coupled with limited internet access and costly services, Tim and friends turned to WiFi to explore another way of connecting separately located computers together. This is how the first community WiFi network in South Australia began.

This origin story has much in common with the advent of the LAN gaming community in Australia. Morris (2007) argues that LAN parties developed due to a lack of affordable high-speed internet access, and it is possible to see a similar drive behind Tim's initial forays into WiFi. However this does not account for why Air-Stream has endured despite the wider availability and affordability of commercial broadband. Between 1998 to 2007, household internet access has more than quadrupled from sixteen per cent to sixty seven per cent (ABS

2008d). Yet, paradoxically Air-Stream has continued to expand. In 2006, there were seventy members and in 2007, the group established a connection with *Southern WiFi*, another community network, extending their coverage to sixty kilometres across the city, and making Air-Stream the largest not-for-profit community WiFi group in Australia.

A distinct feature of Air-Stream is that it is deliberately not built for the purpose of sharing the internet. While many community wireless groups around the world use WiFi to provide free or low-cost access to the internet, Air-Stream make their own version of the internet. Although a grey legal space exists in Australia for people to share internet access across a WiFi connection for not-for-profit use, and some members do this, it is not the focus of the group. Instead, the Air-Stream network is specifically built for local content and communication, facilitating the sharing of information resources such as websites, e-mail, audio, video, multi-player gaming and other forms of internet protocol (IP) communications. As a member of the group put it: 'We are building our-net, not the internet' (Field notes 25.10.06). Put another way, rather than simply adding content to the internet, Air-Stream members are building the very architecture of the internet.

The importance of studying marginal and mundane technologies

In the context of ISP's such as *Telstra*, the largest provider of fixed line and wireless internet in Australia, whose forty seven per cent market share means it services over two and a half million people across a landscape encompassing almost eight million square kilometres (Budde 2007), Air-Stream's accomplishments appear trivial and inconsequential. A compelling reason for studying a seemingly marginal and mundane technology draws on what Latour (1992) calls the 'missing masses'. Latour describes how physicists believe there are 'missing masses' that co-exist with and around larger and more impressive accounts of the universe and once found, isolated and examined can provide indispensable part of an adequate account and help tie everything together. My emphasis here is less on big and small entities because these, as it has been well argued, are problematic terms given micro artefacts can have macro socio-economic impact and vice versa (Michael 2006), and more to do with the fact that 'missing masses' serve so efficiently in everyday routine, often operating on the fringes of larger regimes, that they slip by unnoticed and invisible.

The fact that mundane technologies are often overlooked is another reason why they warrant special attention. Michael explains that ''mundane' refers to those technologies whose novelty has worn off; these are technologies that are now fully integrated into, and an unremarkable part of, everyday life' (2000:3). Doors, sewers, seatbelts, velcro and water

pumps are just a few STS examples that attend to the idea that seemingly unremarkable artefacts and systems make explicit the familiar and taken-for-granted ways in which people make sense of and operate in everyday life (Star 1991, 1999; Latour 1992; de Laet and Mol 2000; Michael 2000; 2006; Mol 2002). Broadly speaking, these studies hold that a close examination of such intertwinings provide valuable interventions in the understanding of the larger dynamics of socio-technical systems. Given the internet has become firmly embedded in everyday life as a means of connecting people together in the western world, (Brown, Green and Harper 2001; Katz and Aakhus 2002; Wellman and Haythornthwaite 2002; Woolgar 2002; Ling and Pederson 2005), this study importantly draws attention towards alternate forms of connectivity beyond the internet.

It therefore holds that a focus on a small suburban WiFi group offers insights into understanding the nature of the broader spectrum of digital technological innovation and knowledge systems as well as providing a new way to re-imagine the possibilities of how communication practices 'might be otherwise' (Bijker and Law 1992:3).

Key themes and questions

The opening field note (19.03.06) illustrates a number of questions this thesis will address, centred around three themes; technological, visual and cultural. To introduce the study I briefly outline key themes and research questions.

The first theme relates to **the nature of (constant) connectivity**. Because WiFi is seen not only as a way of *getting* connected to the internet, but of *always* being connected, it fortifies the notion that connection is crucial without explaining the benefits. Mackenzie has gone so far as to term it 'over-connectedness' (2007:94) and Goggin and Gregg have shown that the desire for constant connection in and of itself is an 'increasingly dangerous form of common sense' and call for researchers to 'challenge the growing consensus that citizens need to 'be connected' to fully participate in and enjoy the benefits of a modern democratic society' (2007:42). Although written nearly a decade ago, it appears little has moved on from Green and Harvey's research into ICT adoption in Manchester in which they found 'the imperative to connect', and argue it 'focuses on the connection itself, rather than what it is to be connected or why' (1999:12). At the time of my study, it is clear that WiFi was being positioned as 'the next big thing' (Docherty 2003; Day 2005; Ward 2006c), yet what is less clear is why constant connectivity is deemed so critical and, moreover, it 'leaves out the question of what *disconnections* are entailed in connecting' (Green and Harvey 1999:12 emphasis in original). As indicated in the introduction, Air-Stream's WiFi network is not

'always on'. What might a group who design, build and fix their own WiFi network reveal about the nature of, and possibilities for, alternative modes of connectivity?

The second theme concerns **DIY technology infrastructures**. Infrastructures by their nature are often concealed, hidden from view and as a result are often neglected (Ackrich 1992; Star 1999). What often makes them visible is breakdown and failure, yet as indicated in the field note, the infrastructure of the WiFi network created by Air-Stream was visible to the thieves when it was working. Tim's and Ron's concern about the use of maps in the theft, reveal how the group routinely make visible their working practices on the website and other public events for members and non-members alike. Considering this is the fifth theft to the network, why do Air-Stream members continue to expose information to public view? And why did the Air-Stream network not completely stop and breakdown when several antennas were stolen? As de Laet and Mol (2000) have illustrated in their study of the Zimbabwe Bush Pump 'B', the term 'working' is far from straightforward when technologies continue to operate in ways unintended by the designer. If the concept of working can take on *fluid* meaning, what significance, if any, do representations such as maps take when something goes wrong?

The final theme is associated with **the Australian cultural context and attending practices.** The field note describes the distance between nodes that require access by car, isolation of sites that enable thieves to do their job as well as native birdlife that perch on antennas. Dealing with these conditions and situations requires quick resourceful thinking in the form of, in this case, an innovative patchwork-style temporary alarm system. Are these circumstances and conditions particular to Australia and if so, how do they shape the way the network is made and represented? As per the title of this thesis, backyards are a central location where community WiFi is made in Australia. Because Australian culture is resolutely suburban[6] (Fisk et al 1987; Ferber et al 1994; Johnson 1994; Webster 2000; Elder 2007; Turnball 2008), backyards are quintessential spaces where notions of what it is to be Australian are produced. This thesis sets out to explore if these mundane and ordinary spaces, and attending materials and practices, also play an important role in Australian development and understanding of new ICTs. This theme is an attempt to discern what might be considered specifically Australian about this version of WiFi and builds on what has been argued about the sociological value of different versions of the internet (Miller and Slater 2000; Goggin 2004; 2007; Ito et al 2005).

[6] At 30 June 2001 more than 8 in 10 Australians (85%) lived within 50 kilometres of the coastline of Australia, up slightly from 1996 (83%) and most people living near the coast live in or near capital cities (ABS 2004b).

This thesis is primarily concerned with the way representations have been addressed within STS and to a lesser extent how they are positioned within the broader context of sociology. Despite the ubiquity of images in the social worlds that form the focus of much research, visual representations in sociological contexts are narrowly defined in terms of the role they take in the construction of knowledge and in what form they are recognised. This neglect has the effect of reinforcing the notion that they are irrelevant or incidental to sociological knowledge. Although the visual has long been marginalised by the privilege of textual accounts, some work has being done by sociologists who advocate integrating the visual deeply into research, not just bracketing it as a method or an object of study (Becker 1984; Chaplin 1994; Cartwright and Sturken 2001; Pink 2001; Knowles and Sweetman 2004; Halford and Knowles 2005; Back 2007; Back et al 2008). In particular, Cartwright and Sturken argue that, 'visual culture is something that should be understood in an analytical way not only by art historians and other "image specialists", but by all of us who increasingly encounter a startling array of images in our daily lives' (2001:4). This reflects the work of Harrison who argues for 'the potential of the visual in sociological research closer to the mainstream enquiry' (1996:75). More recently, this has been taken up in a series of innovative workshops entitled 'Live Sociology' that sought to bring sociology 'alive' by 'extending the media used to communicate research to users, and contributing to debates in the research community about new forms of sociological representation in ethnography' (Back et al 2008). Building on this literature, this study of the culture of a new wireless digital technology aims to go beyond simply including the visual and other forms of representation in research, to consider it central to sociological knowledge.

This thesis is also influenced by recent studies of the role and importance of DIY practice (Waterton and Ellis 2004; Ellis and Waterton 2005; Waterton 2006; Shove et al 2007; Haring 2007; Ito 2008; Laurier 2008). Although these writers address a wide range of subjects and technological artefacts using contrasting methods and theoretical frameworks, they are united by an interest in developing a richer understanding of different communities of knowledge that operate independently of dominant commercial and governmental practice. In these contexts practice is not just what people do but a coordinated series of activities held together by norms and performances (Schatzki 1996; Reckwitz 2002; Warde 2005). Reckwitz defines practice as 'a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood' (2002:250). What this means is that systems, ideas and artefacts only have meaning and value when they are integrated in a context of practice. Therefore, it holds that visual culture can only be understood in terms of the everyday practices involved in making WiFi.

Overall, the questions and themes proposed here are intended to produce an account that is both a critique and contribution to STS literatures concerning visual culture in the development of new ICTs and also to develop and communicate a new framework for use in related sociological study.

Overview of chapters

Chapter Two. Studying science, technology and representational culture in suburban Australia

I begin this chapter with a review of existing WiFi studies in which I identify three key themes and use them to set the background and develop a framework for locating my analysis in the thesis. Firstly, I interrogate the 'imperative' for constant connection (Harvey and Green 1999; Green 2000; Green, Harvey and Knox 2005) that drives much of the discourse that surrounds the internet and WiFi in Australia. Through this I develop a critical approach to the study of technological connectivity. Secondly, I examine the paucity of attention on the visual culture of technological infrastructures, with the exception of STS in engineering and science. I also review ANT literature in order to develop a framework for examining networks that are instable, multiple, flexible and fluid (Martin 1994; Singleton 1998; de Laet and Mol 2000; Mol 2002; Law 2004; Law and Singleton 2005). The final section frames the importance of a study of Australian ICTs by drawing on comparable work undertaken outside dominant American and European centres. It sets up the importance of studying backyards and other mundane and overlooked locations, artefacts and practices. Overall, this review of literature constructs a framework to view the study of backyard technologists in suburban Australia as a lens into understanding larger dynamics of socio-technical systems.

Chapter Three. Researching Australian backyard technologists

This chapter details how I approached a study of backyard technologists in suburban Australia. It begins by introducing Air-Stream, the group under study, its location and respondents who feature throughout this thesis. It then outlines the research design and highlights some of the epistemological, methodological and practical issues that shaped my fieldwork. I discuss the key characteristics of what Hess (2002) calls 'second generation' STS research and the implications for understanding the culture of a new digital technology. I also address the challenges of participating in while studying the representational culture of others and how this relates to existing notions of the visual in sociological knowledge.

Chapter Four. Disorderly design

In this chapter I identify and describe the nature and role of representations at an Air-Stream monthly meeting. I explain how they connect people together, aid recruitment and teach members about new applications, yet they do not conform to the singular, layered, sequential and hierarchical or highly ordered characteristics of inscriptions found in science and engineering contexts in STS. Instead, I draw attention to the multi-dimensional, co-located and sometimes contradictory character of representations made by Air-Stream members. I argue that Air-Stream's scattergun and seemingly messy culture may prove to be more resilient and responsive, ideally suited to the idiosyncrasies of WiFi, the people who make it and their disparate locations. I also introduce and explain the role of the 'barbie' in the making of WiFi, arguing that it too is enrolled in the group as a means of contending with the complexities of the technology. Overall, this chapter unsettles the precise and orderly role of inscriptions as established in STS literature by revealing the disorderly design of Air-Stream's representational culture.

Chapter Five. Representing interruption

According to ANT, systems achieve stability when disparate human and non-human actors accept an assigned role in a complex heterogeneous network (Callon 1986, 1987, 1997; Law 1986; Latour 1990, 1991, 1997). The Air-Stream network is clearly stable. It has operated for over six years and continues to grow in size and strength. It also has, as I have shown, an established visual culture. Yet, members encounter a vast array of interruptions on a daily basis such as trees, birds, bugs and possums, technical complications, a myriad of materials and the weather. I show how rather than tidying up and smoothing out these disturbances, members build them into the network. In this chapter I explore the possibility that it is the group's ability to deal with constant indeterminacy and multiple realities that affords it durability. From this position, I argue that Air-Stream make WiFi not in spite of interruption, but because of it.

Chapter Six. Mods, middlework and making-do

In this chapter I examine how Air-Stream members make their work-in-progress, or *middlework*, visible in the public domain and the consequences this has on how the network is shaped. Although middlework is recognised and valued within STS for its role in the construction of knowledge, it is hidden from public view. Specifically, I trace how Air-

Stream members 'mod' [modify] a range of materials in the process of making WiFi, and how this approach acknowledges and, moreover, celebrates the virtues of a technology that constantly breaks and requires mending. To better understand the nature of this aspect of their visual culture, I introduce the concept of 'making-do': a unique Australian approach to technological innovation and adaptation borne of intractable places and conditions. Then, drawing on Miller and Slater's (2002) study of Trinidadian's who displayed an 'affinity' to the internet, I suggest 'making-do' accounts for why Air-Stream men appear to 'take to' WiFi.

Chapter Seven. Stumbling in digital suburbia

This chapter examines 'stumbling'. Stumbling is a routine Air-Stream activity designed to look for and represent wireless digital 'noise' in specific sites as a precursor to, depending on the strength and direction of local wireless signals, the exhibition of a new or upgrade of an existing antenna. Drawing on Cartwright (1995), I compare stumbling with the X-ray as a technology for inscribing new forms of visual knowledge previously invisible and unknowable. I argue that stumbling can be considered an inscription device because it produces representations of suburbia that are used by members to expand the network. Yet, contrary to much STS literature, Air-Stream's representations do not narrow information or impose a particular way of seeing for the purpose of diagnosis or control. Instead, they render visible a new form of digital suburbia that members use to imagine alternative forms of connectivity between disparate distributed points. Furthermore, because stumbling represents a version of WiFi that has escaped domestic captivity I conclude by suggesting it is feral infrastructure. This lens enables a way of seeing and understanding whom else inhabits these invisible infrastructures and the power struggles that take place within them.

Chapter Eight. Homebrew high-tech

This chapter focuses on the contradictory intersection of homebrew and high-tech. Identifying the tensions between tinkering and more formally acknowledged innovations I argue that homebrew high-tech represents one way of reconciling these conflicts. Drawing on English-Lueck's (2003) study of New Zealand's Silicon Valley highlights the value of different kinds of innovation cultures outside large-scale technology hubs. She shows how local, imaginative and often adapted innovations are not trivialised or overlooked but rather highly valued in the global technology marketplace. In terms of Air-Stream, I explore the importance of reputation and relationships with local ISPs as well the role of sticky tape

used both as a tool and evocation of a way of working, characterised by an ability to adapt. I explore the novelty of homebrew high-tech in attending to and possibly reversing 'the usual binary between commercial/ public versus dominant/private use of communications technology' (Goggin 2007:121).

Chapter Nine. Conclusion

This concluding chapter seeks to revisit the central question posed in the thesis: Can the visual representations involved in making WiFi by backyard technologists in Suburban Australia be considered 'inscriptions' (Latour and Woolgar 1979) or 'conscriptions' (Henderson 1999)? During the course of my ethnography, however, the limitations of this question became evident in view of a technology characterised by ambiguity and instability. Although these influential studies initially framed this research, they do not fully account for an expanded typology, that is, the possibility of alternate forms of visual representations that accommodate multiple, co-located and often contradictory knowledge. This thesis extends beyond inscriptions and conscriptions by letting go stringently ordered and hierarchical accounts of two-dimensional knowledge and moving towards the recognition of a diverse array of multi-dimensional objects gathered together in contingent assemblies. Although this thesis found many instances of mess (Law 2004), mess did not fit with Air-Stream's visual culture. Instead, drawing on local practices such as modding and making-do, I propose these backyard technologists are making a distinct version of WiFi – Australian WiFi. As a result, I have demonstrated the validity of using visual culture as a way of getting at how members of a specific cultural group come to know and understand a new digital technology. This thesis poses both theoretical and methodological interventions in sociology.

Chapter Two.

Studying science, technology and representational culture in suburban Australia

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A review of existing WiFi literature

Despite the rapid growth of commercial WiFi hotspots around the world, the popularity of community wireless networks and the demand for WiFi enhanced devices there is only a small body of qualitative literature that critiques this new digital technology (Sandvig 2003, 2004; Mackenzie 2005, 2005b, 2007; Sawhney 2005; Goggin and Gregg 2007; Gregg 2007; Forlano 2008; Jungnickel and Bell 2008). In reviewing this literature I highlight major themes and ideas relevant to this thesis.

The first concerns the narrative of WiFi's 'always on' connectivity. Several studies offer critiques of media representations of WiFi as 'everywhere' and 'anytime' (Goggin and Gregg 2007: Gregg 2007; Mackenzie 2007; Forlano 2008). They argue that there is a disjuncture between these depictions and everyday reality of use. Further, they suggest that an uncritical acceptance of them is misleading and, more importantly, limits the possible use and imaginings of new wireless technology. For instance, Gregg's (2007) approach focuses on WiFi's impact on the workforce, arguing that while wireless technologies enable people to develop new skills and do it in their own time, these 'freedoms' bring about new anxieties, specifically concerning the labour politics of a 'flexible' and, in many cases, 'dispensable' workforce. 'Always on' connectivity in Gregg's (2007) study highlights the

inability to switch off. In response to Harvey and Green's question: 'what *disconnections* are entailed in connecting?' (1999:12, emphasis in original), Gregg's work draws attention to a disconnection from disconnection. While this study and others like it critically examine the nature of connectivity, drawing attention to the many important and pervasive ways that it shapes and is shaped by socio-political, gender and technical relationships, their work does less to unsettle the certain and stable idea of constant connectivity the way, for instance, Wyatt et al (2002) unsettles the category of 'user' by attending to the 'non-users', 'former users' and 'never users' and Bruns and Jacobs (2006) fragment 'blogs' into 'diary blogging', 'corporate blogging', 'community blogging' and 'research blogging'. There exists, therefore, an opportunity to contribute to this body of work by teasing apart connectivity itself, to see what other forms of connections and disconnections are possible.

Another central tenet of this literature relates to personal reflection, with many writers focusing on their own WiFi experience in urban settings (Sandvig 2004; Mackenzie 2005). Sandvig (2004) draws on his experience of a WiFi hotspot at Speakers Corner in London's Hyde Park while Mackenzie (2005) describes connectivity issues in Piccadilly Circus:

> Embarrassed to be using a laptop on steps covered with tourists and lunching city workers, I spent only a few minutes trying to locate the Broadreach hotzone. Given that the whole area was well within the hotzone, and that access to the network was supposed to be free for that month, it seemed like a good opportunity to see what it would feel like to connect to the Internet in the midst of the London buses, the taxis, the barrage of signage and flows of people moving towards Leicester Square and Charing Cross Road. There was no WiFi signal. I could make no connection. Disappointed, I shut the laptop and walked down toward Leicester Square (Mackenzie 2005:3).

Here WiFi, like the internet (Miller and Slater 2000; Wakeford 2003), is not a placeless or disembodied experience but is firmly embedded in a distinctive material, social and cultural environment, in this case in London. Emphasis on subjectivities and personal engagement with WiFi suggests it is best understood not as a technical artefact but in relation to a myriad of actors such as wireless devices, physical locations, bodies and the emotional experience of connection, or in this case disconnection, in a public place. WiFi is therefore not just a technological infrastructure, but a social, spatial and material intervention. The notion that WiFi is not 'anywhere' or 'anytime' is also central to Forlano's (2008) work on community WiFi in the US. Like Sandvig (2004) and Mackenzie (2005) she focuses on the locations in which WiFi is used:

> (...) 'anytime, anywhere', which alludes to convenience, freedom and ubiquity, is of little use in describing the realities of municipal wireless networks, and, more importantly, it ignores the particular characteristics of communities and the specific practices of users (2008:1).

While Forlano (2008), and others, signal the importance of locating WiFi in specific places and at specific times, there is a paucity of academic research that addresses cultural production and use of WiFi outside the US and the United Kingdom (UK). There is even less about Australian WiFi. Goggin and Gregg's (2007) edited collection of essays about wireless technologies and cultures in Australia is the first of its kind. Explicitly aware of this, they set a research agenda to counter and critique the small yet dominant corporate vision of wireless in Australia: 'Elsewhere in the world – for instance, in Britain and the United States – wireless technologies such as Wi-Fi have been widely discussed, with the imagining of desirable futures often at the centre of public attention' (2007:43). In Australia, WiFi is largely viewed in terms of the provision of pay-for service wireless internet. What research exists in non-US and UK locations tends to take the form of case studies of WiFi projects in under-privileged communities. Examples include the deployment of WiFi as a means of providing internet to remote villages by an e-tuk tuk in Sri Lanka (Tacchi and Grubb 2007) and a rikshaw in India (Cosgrove-Mather 2004). These studies are not about a locally produced WiFi but about WiFi that travels to local places. This signals a gap in the literature for research specifically focused on locally made and used WiFi networks in non-US and UK locations.

Sandvig (2004) and Mackenzie's (2005) work hints at the challenges involved in finding and using WiFi. With Bell, I have written about WiFi in Australia as a 'feral' technology that 'escapes domestication, resorting to an unruly condition requiring of the user an acute and flexible awareness of the fragile ecologies in which they reside' (Jungnickel and Bell 2008:275). While this work echoes the difficulties of finding WiFi it also highlights another reason why many writers rely on personal accounts – the difficulty of finding WiFi users. Perhaps WiFi users are harder to locate because of the invisibility of the technology. Although it is not the prime focus of any of this WiFi literature, a study of the visual culture that surrounds WiFi suggests a way to understand not only how WiFi is found in specific places and used but also how it is made and understood.

Because WiFi is commonly known for providing wireless internet it is seen as an infrastructure, or, rather, not seen at all. Infrastructures are often ignored because they are perceived as 'boring' (Star 1999). They are hidden from view, and thus rarely granted the attention allotted to more visible artefacts and systems. WiFi is an extreme case of this, as Mackenzie (2005) notes: 'Unlike the dazzle of Hollywood cinema's digital effects, the startling mobility of images in recent computer games, or the efflorescent sociality of mobile phones, WiFi is hardly spectacular in any way, shape or form' (2005:2). However, according

to STS literatures, the fact that it is boring and mundane signals potential for dispensing vital knowledge about the practices of everyday life (Latour 1992; Star 1999; Michael 2000, 2006). The lack of work in this area therefore further supports the need to explore WiFi as a 'missing mass' (Latour 1992) for what it might teach us about mundane and yet fundamental socio-technical practices.

Outside academic literature, community WiFi is widely discussed and debated on weblogs and websites. In this area, emphasis is predominantly on how wireless is used as a tool for political activism and less on the reality of making it, despite the fact that many authors are community members themselves. An illustrative example is Sascha Meinrath, the co-founder and president of the *Champagne Urbana Wireless Network* (CUWiN), which provides 'low-cost, do-it-yourself, community-controlled alternatives to contemporary broadband models' (CUWiN 2007). His writing positions community WiFi members as activists in the battle against dominant commercial and governmental forces[7]. This group and many like it[8] replicate existing infrastructural models, yet do so to supply free or low cost internet to communities using WiFi technology. Emerging in this body of work is a preoccupation with market-based economies and the privatisation of infrastructure for profit. There is a distinct lack of attention on other ways of, and reasons for, making WiFi.

While community technology groups have never been a focus of DIY studies (Roush 1999; Leadbetter and Miller 2004; Shove et al 2007), nevertheless it is still a productive lens. My initial field note in the introduction revealed Air-Stream as a group that designs, builds and constantly fixes their WiFi network. Clearly, Air-Stream is engaged in DIY practices. In this thesis I take DIY to mean a hands-on physical engagement with a diverse set of materials and improvised methods for the purpose of creating or repairing something for not-for-profit use outside traditional technology development spaces and times. I do not restrict its definition to home improvements, as it is commonly known (Shove et al 2007:43). In Shove et al's (2007) book about design and everyday life, for instance, DIY is only associated with home renovation even though the book also addresses the amateur use of digital cameras. Moreover, DIY projects are seen as finite. There is little notion of ongoing maintenance. Shore et al's respondents talked about DIY in terms of 'projects' and described them as 'an initial flurry of activity on first moving into their current property' (2007:61). DIY has also been linked to experimental dance culture and environmental activism (McKay 1991), land, housing and transport protests (Searle 1997), culture jamming which involves information

[7] See blog post - *Wirelessing the Revolution: Intro to Community Wireless Networks and Community Wireless Networks as Radical Activism: The Case for Mesh*, Accessed 10.10.08, Available at: http://www.cuwin.net
[8] For other examples see http://www.ilesansfil.org and http://www.nycwireless.net.

warfare against commercial culture (Jordan 2002), hacker culture (Wark 2004) and digital culture remixing (Lessig 2004). Traditionally, DIY culture has been sociologically investigated using social movement theory (Eyerman and Jamieson 1991; Melucci 1989, 1996; Maddison and Scalmer 2006). These studies, however, have been criticised for privileging large sensationalised events over more mundane everyday activities and lacking an interest in the materials made and used by people (Purdue et al 1997; Maddison and Scalmer 2006). As Maddison and Scalmer explain their frustration:

> How do you organise a demonstration? Contact the media? Sniff out a potential ally? These tasks require skill, knowledge and flair. They are the mechanics of successful campaigning. And yet lovers of abstraction rarely think about them. The field of 'social movement studies' falls almost silent in their presence (2006:44).

DIY is also predominantly seen as an individual pursuit. Clearly indicated by its name, DIY is about doing-it-yourself yet Air-Stream members collectively make WiFi. They do-it-together (DIT).

Guiding themes

Looking across these empirical WiFi studies what is evident is that only a small body of work deals with WiFi and in what exists there is a lack of in-depth ethnographic engagement with the makers and materials of these infrastructures. These networks do not simply land in communities. What are they made of? Who builds them? What happens when they break and who fixes them? It is my argument that what is missing from this larger body of research is a focus on the physical hands-on building of wireless networks, the materials used, the processes and the mundane, trivial and ordinary places in which they are made. Even when the authors are practitioners themselves they tend to omit the mistakes and mess of everyday practice in favour of discussions about larger socio-political forces. This is not to say these are uninteresting or unimportant issues, rather that the actual infrastructure that underpins this work is overlooked. These studies also hint at the challenges of finding and using WiFi due to its invisible nature, thereby signalling the importance of its visual culture and yet never fully attending to it. Being viewed as an infrastructure goes some way to explain this and, equally, reinforces the need for further attention. Moreover, studies undertaken outside dominant US and European sites are also lacking. Taking as a focus the culture of WiFi made by Australian backyard technologists this thesis attempts to fill the gap in this small but growing body of WiFi literature.

The rest of this chapter will address three key themes identified in these WiFi studies in relation to broader STS literature: **the nature of technological connectivity in Australia**, **DIY technology infrastructures** and the role and importance of **the Australian cultural context and attending practices** on the design and development of ICTs.

I. The nature of technological connectivity in Australia

> By the end of the Howard period, market failures in the information technology area, particularly the provision of Broadband, were becoming more apparent with Kim Beazley (2006) arguing that Australia needed nation-building economic strategies because: 'We don't have an information super highway — we've got an IT goat track' (Johnson 2008:3).

As Johnson (2008) points out, Australia has trailed behind the rest of the world in providing affordable access to internet infrastructure. What is implicit in this account of Australia's struggles to connect its constituents, is a sense of shame and embarrassment, signaled in the description of the super highway as a IT goat track, of being left behind in a global context. Getting connected, in this formulation, is a national (and international) imperative.

Since the mid 1990s, the internet has become an increasingly significant component of Australia's international, economic and cultural standing in the world and a site of increasing complicated political discourse. Allen and Long (2004) explain how governmental campaigns in 1995 associated the internet with national identity. They write: 'These campaigns took the form of trying to convince Australians to use the internet – that to be 'Australian' meant getting online – and thus linking citizenship to internet use' (2004:232). In May 2006, Senator Helen Coonan, then the Minister for the Department of Communications, Information Technology and the Arts (DICTA), addressed the fifteenth World Congress on Information and Technology in Texas, US. She spoke of Australians with 'significant expertise in wireless and software applications' in 'an environment that fosters ICT development, application and innovation' that is 'leading to innovative solutions both in Australia and internationally' (Coonan 2006). Similarly, it was clear in the 2007 national elections that digital connectivity was a pivotal platform. Kevin Rudd, Labour contender and now Prime Minister, announced his plan to 'revolutionise Australia's internet infrastructure', leaving little ambiguity about the role and importance of the internet in Labour's broadband policy (ALP 2007).

> Australia's future productivity, competitiveness and wealth creation relies on world class infrastructure. In the global economy of the 21st century, no aspect of infrastructure is more crucial than advanced communications networks (ALP 2007:3).

One of the most obvious challenges in this vision, however, is an inability to adequately service rural and remote parts of a very large country and address the low speeds and restricted download issues in city centres. According to the 2006 census, sixty four per cent of households used the internet at home, with sixty eight per cent broadband connection (ABS 2008b). This marks a significant change from the beginning of my study in 2005, when fifty six per cent of households were connected to the internet, with sixteen per cent broadband (ABS, 2005b)[9]. Yet, despite this increase, slow speeds, capped download limits and narrow availability place Australia far behind many other comparable nations. In the UK, for instance, speeds average thirteen megabytes per second [mbps] while in Australia they are just barely over one mbps (SMH 2006). Many argue that the current situation is the legacy of a telecommunications monopoly (Clarke 2004; Meilke 2004; Rennie and Young 2004). Since 1975, *Telstra,* the Government owned telecommunications organization, has dominated the Australian telephony and internet industry (DICTA 2006b)[10]. Clarke argues that the Government's 'failure to prevent monopolistic behaviour and counter-competitive pricing' has lead to a lack of choice of alternatives, high prices and for some in more rural regions of the country unreliable or non-existent connection to the internet and a 'less rosy' outlook for the future (2004:39). Similarly, Given (2008) writes of a nation's frustration:

> The policy said telecommunications carriers' plans for network development had remained unfulfilled for too long. Australia risked being 'left behind' in the most important form of infrastructure for the global economy of the twenty-first century. On 'entry level 256 kbps broadband' per 100 inhabitants, Australia was 17th out of 30 OECD countries, a position that hadn't improved in two years. Rupert Murdoch thought the situation a 'disgrace'. James Packer said it was 'embarrassing'. Fairfax's David Kirk talked about 'fraudband' (ALP, 2007). Consultant Mark Pesce said Australia was 'basically an internet backwater ... Broadband is merely the latest chapter in a very old story' (2008:6).

A development, during the period of my study, in the Australian government's approach to digital connectivity is the ALP's policy for mandatory filtering of the internet by all ISPs for

[9] 56 per cent of all households in Australia is approximately. 4.1 million subscribers (ABS 2005b).

[10] *Telstra* owns over fifty per cent of the internet market and seventy five per cent of the phone market and although some competition has entered the industry, it leads with slow and expensive packages. Following is an example of *Telstra's* (2008) internet packages - all based on 12 and 24 month contracts (Accessed 07.08.08, http://my.bigpond.com/internetplans/broadband/wireless/plansandoffers/default.jsp):

Name	*Speed (Down/Upload)*	*Usage Allowance*	*Monthly Price*
Fast	256/64 kpbs [kilobytes per second]	200mbps	AUS$29.95 [GBP£15]
Faster	1500/256 kpbs	400mbps	AUS $39.95 [GBP£20]
Fastest	Up to 20mbps	60gbps [gigabytes per second]	AUS $149.95 [GBP£72]

all Australians. This 'Clean-Feed' policy will potentially slow down Australia's already sluggish internet by thirty and seventy-five per cent (ACMA 2008) and many question the appropriate use of taxpayers money (AUS$44million or GBP£21million). There are also fundamental concerns about censorship and free speech, given the chance it might 'incorrectly block 10,000 sites in every million' (EFA 2008). Critics have drawn similarities between the internet in Australian with China, Burma and North Korea; countries renowned for their draconic censorship laws. In fact many have termed it 'The Great Aussie Firewall' (EFA 2008; Oates 2008, Smith 2008).

> The Clean Feed is bad policy. In short, even if it worked the filter would be terrible policy. By censoring the entire country's Internet access down to the level of a child of indeterminate age, it robs Australian adults of ability to make their own decisions about what content they view. One size doesn't fit all (EFA 2008).

My aim here is to communicate the intense drive to get Australians connected, and, moreover, the narrow and often deterministic nature of what is considered by large-scale institutions to be connectivity. This, I argue, is clear evidence of 'the imperative to connect' (Harvey and Green 1999; Green 2000; Green, Harvey and Knox 2005), which Green (2000) explains as:

> (T)he urgent political and commercial insistence that everyone must connect to ICTs, and must do it now, is heavily loaded with this idea of getting somewhere. Connection is represented as an objective and inevitable truth about today's world: those who do not connect will not get anywhere – socially, economically and, increasingly, it seems, politically - and as a result will be excluded (2000:1)

Whereas once Australia was largely dependent on the wool industry, with an economy that 'rode on the sheeps' back' (White 1981:149), connectivity via the internet is central to its economic present and future. It is this technological vision, of connection for all Australians, which is central to my critique. Yet, as the activist group, Electronic Frontiers Australia (EFA) point out 'one size doesn't fit all' (2008).

My intentions in this first section are not to explain how this has arisen or predict Australia's technological future but to highlight what is absent in this debate. It strikes me that the history of Australian infrastructure is implicit in current understandings of Australia's version of the 'imperative to connect'. The infrastructure of television, electricity and radio has been designed to *push* data to terminal connections; end points located in offices and homes. These one-way systems are designed for consumption, not for participation. Given broadband download speeds are on average eight to twelve times faster than upload speeds,

it is clear that the infrastructure of the internet is similarly configured[11]. Even the moniker 'superhighway' lends itself to one-way travel, vigorously bound by rules and regulations. It does not accommodate a vision of group facilitated collaboration and creative production. This system supports an idea of connection as something to consume. In contrast what a study of Air-Stream promises is a way to consider a more individually owned yet collectively operated version of WiFi. As Goggin writes, 'there is something exciting in the prospect of user-led wireless networks leaping over the limits of current home-based wireless routers and playing a real role in shaping future networks' (2007:127). Yet, as Goggin and Gregg have argued, wireless technology is most often represented in terms of 'competitive discourse' and 'nation building exercises such as railways and roads' and is 'embedded in terms of responsibility and efficacy' (2007:41). What is not acknowledged is the possibility of other means of getting connected and other versions that unsettle the stable idea of constant connectivity. The internet in Australia is dominated and therefore shaped by commercial models of Government and large scale technology organisations to the point where alternate technology practices do not 'figure much in the commercial realm or in policy making' (Goggin 2007:122). This thesis draws attention to other ways of, and reasons for, making WiFi. Specifically, it highlights other WiFi makers beyond pay-for-internet services provided by ISPs and government organisations. The fact that Air-Stream continues to grow in parallel with strengthened commercial internet provisioning in Australia, makes it an interesting target for investigation.

II. The visual culture of technology infrastructures

The paradox of DIY visual infrastructure

In the space of a decade, ICTs such as the mobile phone, computer and internet have become firmly embedded in professional, personal and social contexts and form the focus of a large body of academic scholarship (Brown, Green and Harper 2001; Katz and Aakhus 2002; Wellman and Haythornthwaite 2002; Woolgar 2002; Ling and Pederson 2005). Although debate continues about whether these technologies have brought forth accelerated and unprecedented change and pose radical social transformation or simply re-inscribe existing cultural practices, what cannot be dispelled is the increasing mass of materials that accompany their widespread use (Jenks 1995; Harrison 1996; Mirzoeff 1999). Harrison argues that 'we are surrounded by visual phenomena and images which display culture and

[11] Typical Australian download speeds for Adsl2+ range from 12 mbps up to 24 mbps. For upload they range from 1.0 mbps up to 3.5 mbps (Accessed 12.11.08, Available at: www.squidoo.com/compare-broadband-plans).

particular aspects of it' so much so that 'it is a central dimension of social life and social being' (1996:77). This proliferation has implications for understanding who we are and where we belong because, as Mirzoeff writes, 'it is not just part of everyday life, it is everyday life' (1999:1).

Visual culture is broadly defined as the visual representations, practices, events and experiences that shape and are shaped by everyday practice (Jenks 1995; Mirzoeff 1999; Evans and Hall 1999; Sturken and Cartwright 2001; Dikovitskaya 2005). It emerged as a new field of academic scholarship in the mid 1990s and contends that the stories we tell have a direct influence on how we come to know the world. Although Mirzoeff argues that 'human experience is now more visual and visualized than ever before' (1999:68), this thesis draws less on the notion of a universal change in human ability and more on the idea that this visual phenomenon is characterised by 'the spread of information machines in the present' (Poster 2002:68). This proliferation of visualising devices means that many different kinds of people, including the backyard technologists at the core of this thesis, have access to tools for making and means to distribute their own visual materials, previously available only to large-scale organizations. For instance, Ito's (2005) work on *otaku*, a Japanese term for people obsessed with anime and manga, illustrates the shift of disparate and marginal subcultures into the mainstream and their developing legitimacy and widespread influence:

> The activities of otaku may seem extreme and marginal, but my sense is that otaku culture is one prototype for emergent forms of literacy. (...) the growing visibility of otaku culture worldwide seems symbiotic with the ascendancy of visual culture and communication in the 21st century (2005:1).

Hine (2000) also demonstrates the influence of amateur websites and weblogs in her ethnography of the Louise Woodward case, in which an English nanny was accused of murdering a child in her care. Hine argues the web 'opens up the possibility for individuals to communicate on a worldwide basis and at least to some extent to compete with the media organisations' (2000:73). The growth and influence of these individuals is illustrated in newspaper articles: 'The terrifying power of the bloggers' (Carr 2004), 'Ignore bloggers at your peril' (Johnson 2006) and 'Spread of online movie clips shows *YouTube's* influence' (Kiss 2006). It also strongly features in this opinion piece:

> The new culture on the Web is all about consumer creation: it's composed of things like the nearly 30 million blogs out there and the 70 million photos available on Flickr. With a click of the mouse, anyone can be a journalist, a photographer, or a DJ. The audience - that 1 billion-plus throng linked by the Web - itself is creating a new type of social media (Schonfeld et al 2006).

This so-called 'new culture', commonly termed Web 2.0, promises a paradigm shift in the nature of interaction on the internet away from a focus on individual consumption, characterised by the first version of the internet (Web 1.0), to one that privileges user-led content generation and participation. The latter reflects Tim Berners-Lee's original concept of an internet that was not just for readers, but for writers as well. In March 2008, *New Scientist* reported that thirty two per cent of consumers saw themselves as broadcasters (Gilmore 2008). But it is not only DIY activity *on the internet* that is making an impact and changing the way we think about new technologies. There is also significant DIY activity surrounding the infrastructure *of the internet*. While only a few people attempt to reengineer the telephone or the television there are hundreds of volunteer community groups all over the world united by an interest in collectively remaking computer networks that underpin these popular online knowledge systems (Sandvig 2004; Mackenzie 2005, 2005b, 2007). Yet, infrastructures seldom get the attention they deserve because they are 'boring' (Star 1999). Rarely are they considered exciting opportunities for imaginative endeavour.

Star (1999) has done much to advocate the study of infrastructure by pointing out that it is not the infrastructures themselves, but how we tend to look at them that is boring. She argues that it is only through a study of the unstudied, the things we take for granted, that we can hope to see new and previously neglected connections and meanings. The problem in overlooking infrastructures like WiFi, and assuming they are simply another channel for more exciting content-based applications is that we neglect how things 'might be otherwise' (Bijker and Law 1992:3). Star explains:

> The ecology of the distributed high-tech workplace, home, or school is profoundly impacted by the relatively unstudied infrastructure that permeates all its functions. Study a city and neglect its sewers and power supplies (as many have) and you miss essential aspects of distributional justice and planning power (Latour and Hermant 1998). Study an information system and neglect its standards, wires and settings and you miss equally essential aspects of aesthetics, justice, and change. Perhaps if we stopped thinking of computers as information highways and began to think of them more modestly as symbolic sewers, this realm would open up a bit (1999:379).

Infrastructures are pivotal to the provision of many essential services, and in line with Star's (1999) argument, they warrant extra special attention. Aside from being boring, another problem is the practical difficulty of studying them. As Star notes, they are only visible when something breaks down and even then, they 'tend to be squirreled away in semi-private settings or buried in inaccessible electronic code' (1999:378). Moreover, the study of infrastructure is not the study of a 'thing' but rather an investigation of a series of

relationships and meanings they hold for people. Star argues against the idea of a monolithic infrastructure that holds a universal meaning for everyone.

To counter this, a one way of studying the complexities of an infrastructure is to examine how it is rendered visible by the people who make and use it. A good example of this is Haring's (2007) study of male ham radio hobbyists in the US in the 1950s, through a study of the vast body of amateur hobby publications; club newsletters, technical handbooks and local media journalism. Her study illustrates how a marginal infrastructure has direct implications in the shaping of social, technical and gendered encounters in the radio technology industry. Importantly, she shows how an examination of technological infrastructure 'points toward broader questions of how we think about and think with technology' (2007:162). Haring believes these types of studies provide a unique perspective precisely *because* they address technologies that are often so 'pervasive and naturalised' they have become invisible (ibid). Therefore it stands that rendering these types of infrastructures visible is important in understanding the role they play in the construction of broader socio-technical systems.

This thesis aims to bring together the study of visual culture and WiFi infrastructure made by backyard technologists. The consequence of this fusion is DIY visual infrastructure. Under this rubric I explore the nature and meaning of the culture that surrounds WiFi. There is however a paradox implicit in this focus. While the study of DIY infrastructure draws attention to a largely invisible entity, a focus on visual culture highlights the way knowledge is represented.

Visual culture in the development of ICTs

Because visual culture is such a broad discipline, I limit my focus to literature that explicitly focuses on the intersection of visual culture and ICTs and I begin by drawing on Alpers (1984) to outline its significance for sociology.

What distinguishes Alpers' (1984) writing from other art historians and makes it interesting to Latour (1990) and Henderson (1999) is her association between science and technology advancements and visual representations. She argues that seventeenth century Dutch visual culture permeated all aspects of society, not just the world of science.

> In Holland the visual culture was central to the life of the society. One might say that the eye was a central means of self-representation and visual experience a central mode of self-consciousness. If the theatre was the arena in which the England of Elizabeth most fully represented itself to itself, images played that role for the Dutch (1984:xxv).

The way a society represents 'itself to itself' is its visual culture. Alpers reveals the link between new ways of seeing and new ways of rendering the world in material form. Drawing on her work, Latour writes that visual culture contributes to 'how a culture *sees* the *world* and makes it visible' (1990:30). He argues that visual culture is often seen as a metaphorical 'worldview', but in Alpers' writing it is given material form and presents both 'what it is to see and what there is to see' (ibid).

As I have outline in Chapter one, visual representations in sociological contexts are narrowly defined in terms of roles they take and the forms they are recognised in the construction of knowledge around ICTs. Recent research concerns websites (Turkle 1996; Chandler 1998; Hine 2000), photoblogs (Cohen 2005), gaming (Taylor 1999) social networks (Hampton and Wellman 1999, 2000), issues such as the social implications of mobile phone use in cars, buses, trains and at home (Laurier 1999, 2001; Brown, Green and Harper 2001; Katz and Aakhus 2002; Glotz et al, 2005), places of use (Wakeford 1999, 2000, 2003) and fan communities (Baym 2000). While they signal how people actively make and shape place, build personal identity and social relations in a variety of multi-dimensional ways afforded by technology they largely overlook the significance of visual representations in the complex co-ordination of everyday life. More broadly, research into technologies such as the microwave (Cockburn and Ormrod 1994), household appliances (Chabaud-Rychter 1995) and the television (Silverstone and Hirsh 1992) take into account visual aspects in a complex arrangement of socio-technical factors but again, little attention is directed towards the nature and role of visual representations. Overall these literatures closely attend to how technical artefacts are designed, made and used and how, where and why people use them in local and global networks, but pay little attention to visual culture per se.

Visual representations have long been marginalised in British sociology and there is still a clear and definite gap between what is considered valid and rigorous sociological practice. In many cases, as Chaplin notes, 'the verbal analyses the visual' (1994:2). She argues that the visual has much to offer sociology in terms of theoretical concerns and methodological practice but the distance between the discipline and object of study needs to be reduced with a collaborative approach that engages with feminist and post-positivist approaches.

> For these approaches indicate that the sociology *of* a topic be replaced with a sociology which puts less distance between itself and the topic area, or data, that it studies; and this in turn implies that the distinction between verbal analysis and visual representation-as-data should become less-clear-cut' (Chaplin 1994:16).

Looking broader still, one of the few places where visual culture is addressed in sociology is the study of commercial advertisements. What is characteristic of this literature is distance between the researcher and the object of study (Williamson 1978; Goffman 1979)[12]. Visual representations might be central to these studies, but they are far removed from the contexts in which they were made and used. Despite the ever-increasing evidence of visual forms of communication and emergence of new technologies, rarely are visual representations seen as central to sociological studies of ICTs.

STS approaches to representational culture

One of the few places where visual culture takes a prominent role and ethnographic focus in sociological research is in STS. Latour and Woolgar's (1979) study is one of the most influential ethnographies in this area of scholarship. Based on two years of research in the Salk Institute in San Diego US, it was one of the first to venture into the source of scientific knowledge, the laboratory, to see first hand what scientists actually did. Previously, science was considered placeless, universal and ubiquitous (Kuhn 1970; Popper 1972). This study was the first of many that sought to ground science studies. Thirty years on, this research continues to influence a body of literature that holds at its core the role of representations in the fields of science (Knorr Cetina 1981, 1999; Callon, Law and Rip 1986; Law 1986a, 1986b; Latour 1987, 1992, 1998, 2005; Lynch and Woolgar 1990), technological design and innovation studies (Callon 1986, Cockburn and Ormrod 1994: Bijker 1995), medical imaging (Martin 1994; Cartwright 1995; Treichler et al 1998; Mol 2000), engineering (Henderson 1999; Bucciarelli 2002), law (Latour 2004), and architecture (Yaneva 2005).

[12] Williamson (1978) and Goffman (1979) explore commercial advertisements using a semiotic approach to uncover the mechanisms through which meaning is encoded in messages. Williamson (1978) illustrates a number of ways in which the system of signs operates in different ads. One example features Catherine Deneuve, the renowned French film actress and a bottle of *Chanel No. 5*. She highlights how prior knowledge about the actress as sophisticated and stylish is required to make the connection between the signified objects and understand the meaning that is generated. Goffman (1979) draws on the slippage between what is represented, in hundreds of advertisements featuring women and men, and what is actually signified by taking into account themes and patterns that are revealed across these representations. His work illustrates socially defined constructions of masculinity and femininity. This approach, based on semiotics, the study of codes and signs found in the structural approach of linguistics (Saussure 1915; Barthes 1964), takes the object from the origin of its production and consumption and considers it in relation to broader social and cultural frameworks rather than those attributed by individuals in specific situations.

The central tenant of Latour and Woolgar's (1979) study is the role played by "inscription devices' which Latour defines as 'any set-up, no matter what its size, nature and cost, that provides a visual display of any sort in a scientific text' (1987:68). This means an inscription device can be a digital telescope or a scientific student observing an experiment, equipped with paper and a pencil. Regardless of the nature of an inscription device, Latour and Woolgar argue they are important because they produce 'inscriptions' that represent knowledge in the form of graphs, images and diagrams. Using this concept, the laboratory was transformed into a 'system of literary inscription' through which they found they could understand the visual culture of scientists (1979:52).

Henderson's (1999) work is relevant to this thesis because she directly builds on Latour and Woolgar's (1979) work in her study of the visual culture of engineering. She defines the visual culture of engineering as 'a particular way of seeing the world that is explicitly linked to actual material experience in rendering that world' (1999:9). Henderson develops the term 'conscription' to accentuate the work that engineering sketches do. She writes: 'Conscription devices, a subgroup of inscription devices, enlist group participation and are receptacles of knowledge that is created and adjusted through group interaction with a common goal' (1999:53). In addition to inscribing knowledge, she argues, engineering sketches *conscript* actors in certain types of action. Henderson's work therefore illustrates how important representations are not only to the production of engineering 'facts', but how crucial they are to the actual building of objects. In terms of this thesis, Henderson's concept of conscription is useful for exploring the role visual representations play in determining who can and cannot participate in wireless developments and how Air-Stream's WiFi network is made.

Because this thesis sets out to explore inscriptions and conscriptions in relation to Air-Stream's visual culture, I detail key features of these theoretical lenses.

Knowledge is stable and mobile. Two of the most crucial properties of an inscription are that they are 'immutable' and 'mobile' (Latour and Woolgar 1979). The fact that they do not degenerate when reproduced and can be widely distributed means they can be used to build up a persuasive and powerful argument. Conveniently, graphs and sketches do not rot, smell or change in any way uncontrolled by the author. As a result, Latour and Woolgar (1979) show how scientists are able to exert power beyond the walls of the laboratory and achieve long distance control because inscriptions always point to a fixed reality.

Stability is also crucial to Henderson's conscriptions. Henderson argues that representations are 'the glue that holds communication together' (1999:59). The way they stick people

together, however, defines what is and is not acceptable and determine the nature of certain activities. Closely observing engineering practice, she found that, 'Visual objects not only shape the final products of design engineering but also influence the structure of the work and who may participate in it' (1999:27). Conscriptions determine how and what type of work is done. The thefts to Air-Stream's network highlighted the fact that the group's visual representations are available to members and non-members and have official and unofficial use. How members contend with this and many other interpretable features of their WiFi network is an area that will be explored in detail in this thesis.

Knowledge is ordered. Latour and Woolgar (1979) show that power is not held in a single inscription but rather in 'cascades' of data. In addition to helping to convince others, ever increasing cascades of inscriptions draw from and relate to the one before, thereby making refutation difficult. Latour writes, 'the phenomenon we are tackling is *not* inscription per se, but the cascade of ever simplified inscriptions that allow harder facts to be produced at greater cost' (1990:40). Inscriptions therefore cannot be multiple or mutable, or else they cease to be reliable representations of a fixed reality.

Henderson, too, shows that information flow is not natural 'but rather must be constructed interactively by the human and nonhuman actors involved' (1999:59). She describes an engineering student reprimanded for drawing a cylinder incorrectly, thus revealing the presence of a visual culture that produces a rigid view of the world. Uniform to these studies is a clear description of place, actors, actions, devices, materials, time and set rules that together constitute a highly ordered system a novice must follow to attain membership to a specific culture. Given Air-Stream's network is located in diverse sites across the city and its members make WiFi in their spare time around other commitments, a central concern in this thesis is how they order knowledge such that it is communicated throughout the group.

Knowledge is erased. Another core task of an inscription device is to simplify and reduce information into a form by which others can comprehend, compare, contrast and categorise it. The original elements, the raw materials, methods, people and places are used discarded or erased from the final form so to reduce the possibility of alternate interpretation and misunderstanding. This is neither an accident nor consequence of the inscription process but a deliberate move. Latour and Woolgar have shown how inscriptions have a 'direct relationship to 'the original substance'' from where they originate but the 'intervening material activity and all aspects of what is often a prolonged and costly process are bracketed off' (1979:51). This is what Latour calls 'chain of transformation' or 'circulating reference' (1999:70). Tracing the movement of Amazonian soil in the jungle to a diagram in

a science journal he found that, 'Stage by stage, we lost locality, particularity, multiplicity and continuity, such that in the end, there was scarcely anything left but a few leaves of paper' (1999:70). 'Circulating reference' refers to the fact that the final inscription bears a relationship to the original substance even if the process is erased. There is a similar disjuncture in engineering between the process and the final fact. Henderson writes about the realities of 'messy practice' and the visual techniques enrolled that keep them hidden from outsiders, in order to preserve the 'mystique' of the discipline (1999:185). The idea that 'daily practice kills the aura of high tech' explains why engineers were embarrassed when she observed the messy reality of their design process (1999:193). She writes: 'The aura of high tech and the use of new technologies such as CAD as symbolic tools in engineering continue to add status through the mystification of the mundane and messy work practices that are necessary to accomplish the goals of the job' (1999:196). Thus, a crucial aspect of inscriptions is the clear distinction rendered between the messy behind the scenes process and the professional public worldview.

Knowledge is primarily two-dimensional. Science inscriptions visualise an information flow from three-dimensional form to a two-dimensional abstraction. Rats and chemicals are delivered to the lab where they are transformed through experiments, using various machines, into diagrams and graphs for publication. Engineering drawings travel in the opposite direction. They begin as two-dimensional sketches with the ultimate aim of producing a three-dimensional object, such as a building. The relationship of dimensionality to visual representations has implications for a study about WiFi because it simultaneously occupies multiple dimensions in the form of maps, antennas, websites and WiFi signals.

As it is relevant to my study, I briefly draw on the way representational dimensionality is critiqued in broader STS literature (Martin 1994; Yaneva 2005; Myers 2008). Martin (1994), for instance, is not convinced that the two-dimensional model of scientific inscriptions fully captures representational knowledge:

> In laboratories, initial messy data are organised into patterns, simplified, and eventually visually represented in a table or a graph. Although Latour argues convincingly that these graphic traces are what have the most powerful effects in science, I am less convinced by his claim that the model can be extended to all society' (1994:163).

In contrast, Martin shows how scientific knowledge about the body is represented in multi-dimensional forms 'involving flexible, complex systems' that 'are in fact diametrically opposed to flat, static models (1994:164). Yavena considers architectural models to be 'visual representations' and 'major visualisation tools' and drawing on Henderson (1999),

she likens these three-dimensional objects to engineer's sketches, arguing they serve as 'social glue' in the facilitation of communication between architects and their complex networks of clients and contractors (2005:872). Similarly, Myers (2008) examines three-dimensional modeling as well as the bodywork of protein crystallographers and argues that this new focus poses 'a range of questions for studies of visual cultures and knowledge practices in the computer-mediated life sciences' (2008:163). In fact, Sturken and Cartwright have argued that it is 'impossible to talk about computer media as a purely visual set of forms' and warn against analyzing 'images apart from sound, dimensional from and other modes of representation' (2005:344). This multi-dimensional work suggest ways to consider how the study of visual inscriptions in STS might encompass more than single-dimensions.

The study of representations in STS primarily attends to the construction of inscriptions and conscriptions that are stable, immutable, ordered and are designed to hide the messy reality of practice. In essence it documents a series of shifts: from disorder to order, private to public, obscurity to conformity and invisible to visible. These are all important ways of thinking about knowledge practices and ones that I will return to throughout the thesis.

Approaching WiFi through Actor Network Theory (ANT)

Henderson's focus on 'the visual documents and the interactions around them that together structure the design process' (1999:8), enrols an approach heavily influenced by ANT. ANT emerged from early science studies in recognition of the role played by non-humans as well as humans in complex heterogeneous networks and continues to influence a wide range of STS (Callon 1986, 1997; Law 1986b; 1994; 1999; Star 1991; Latour 1990, 1992, 1999; Law and Hassard 1999). Rather than privileging the role of technology or that of society in the shaping of a new artefact or system, it contends that both human and non-human actors are equally constituted and powerful. Importantly, this means that representations do not exist in isolation but are embedded within actor-networks and explains why Henderson (1999), in the process of tracing the production of a new surgical instrument, examines not only engineering sketches but also rabbits, biologists, marketing departments, instruments, technicians, tools, engineers, cataracts and many others. In my thesis, ANT provides a way to examine the diverse range of human and non-human actors involved in making WiFi in suburban Australia.

Early ANT literature as been criticised on two major accounts: the invisible work and messy reality that keeps networks stable is often overlooked or entirely erased and that networks

are too often viewed as rigorously centred, ordered and imposing (Latour 1999; Law and Hassard 1999; Law and Singleton 2005). Latour writes: 'The managerial, engineering, Machiavellian, demiurgic character of ANT has been criticised many times' (1999:16). More recent ANT inspired research offers far less stable and ordered interpretations of how systems and artefacts operate (Martin 1994; Singleton 1998; de Laet and Mol 2000; Mol 2002; Law 2004; Law and Singleton 2005). As Law and Singleton write, 'if we want to understand objects, to characterise and study them, then we need to attend as much to the *mutability* of what lies invisibly below the waterline as to the immutability of what lies invisibly above the surface' (2005:337 emphasis in original). I briefly critique key ANT studies and highlight their innovations to support my analysis in later chapters.

Martin (1994) presents the idea of the body as a *flexible* entity in contrast to a fixed and rigorously bound fortress. Studying representations of the body inside and outside the laboratory walls she draws comparisons with contemporary work practices, arguing that both have come to represent 'the image of a flexible and innovative body poised to respond in a continuously changing environment while constantly communicating with other such bodies' (1994:215). Mol (2002) focuses on the body as well, but her view is *multiple*. She unsettles the idea of a disease, in this case atherosclerosis, as a stable or defined entity. She writes, 'there is no longer a single passive object in the middle, waiting to be seen from the point of view of a seemingly endless series of perspectives' (2002:5). Instead, she shows how it evades neat and defined representation by taking multiple forms, not all of which can be seen or understood by everyone; in skin, blood, x-rays, tests, statistics, reports, pain, walking, doctors, scientists, patients and their families. This means 'there are different versions, different performances, different realities, that co-exist in the present' (Mol 2002:79). But this multiplicity does not result in fragmentation or dissolution of the power of knowledge. It does not mean that the surgeons cannot operate or that people cannot be diagnosed or, for that matter, healed. Mol explains how the disease is made to cohere in an assemblage of visual representations and practices including images, conferences, documents and files. Moreover the central point of her argument is the presence of ambiguity and uncertainty. She shows how different experts have multiple perspectives on one object – the body – yet cohesion is still possible. She shows how uncertainty, untidiness and ambiguity actually enable smooth transitions between points in the hospital because each person produces and maintains their own version of the disease, according to their discipline of knowledge, in order to do their job. These representations do not compete or operate in a hierarchy but rather are assembled and re-assembled in new spatial configurations according to a patient's individual symptoms. Far from fragmenting

knowledge, Martin (1994) and Mol's (2002) studies reveal how flexibility and multiplicity serve to produce strong and resilient artefacts and systems.

Singleton's (1998) study of the UK cervical screening programme (CSP) demonstrates the achievement of durability that derives from *instability*. The central point of her argument is that a durable system 'does not require stable and unequivocal entities as its constituents' (1998:86). She shows how the laboratory plays a clear and stable role in CSP in the provision of definite diagnosis and precise recommendations. She also reveals the presence of ambiguous results, discrepancies in sampling procedures and multiple possible interpretations of data render it a site of indeterminacy and instability. She describes how lab technicians deliberately draw attention to the many possible interpretations and uncertainties in their daily work. She provides examples such as a 'thick' sample that requires the technician to 'carefully wipe off some of the excess with a tissue' in order to avoid cross-contamination on the slides. This illustrates the way technicians are able to 'analyze samples that are not 'ideal' as well as those that are' (1998:93). Similarly, what appears normal to one scientist may be abnormal to another yet the 'laboratory incorporates this and accepts it as part of its role, ambivalently saying that it is influential but that 'this does not make too much difference'' (199:94). This is no accident. She shows how the 'marriage' of instability and stability renders the laboratory capable of dealing with the intense vagaries of daily practice. In fact, she argues that the success and efficacy of the system hinges on this paradoxical partnership.

> Contrary to what most recent science and technology studies would expect, the practice of the CSP is characterised by instability and multiplicitous identities. Moreover, this instability and multiplicity actually contributes to the continuity of the program (1998:86).

Highlighting these and many other complex and contradictory daily challenges reveals how the laboratory 'actively constructs but simultaneously accommodates instabilities' (1998:92). This means that instability is not simply tolerated but considered vital to durability and efficacy of the CSP programme. Singleton found that CSP *relies* on doctors being both 'bad' and good' sample takers, which enables lab technicians to present themselves as resourceful and skilful, able to adapt and produce results irrespective of the ambiguous task laid before them (1998:102).

While Singleton demonstrates how the lab stabilises instability, de Laet and Mol's (2000) study of the Zimbabwe Bush Pump 'B' shows how a technological artefact can *fluidly* adapt to changing conditions. Widely distributed throughout Zimbabwe, the pump is considered a success, even though, over time and is differently configured by users in different locations.

When things break for instance, they are repaired or adapted, often using unexpected materials such as sticks and leather. In some cases this means that the pump looks and operates differently in every village, but this does not matter because it is still recognisable as the Bush Pump 'B'. In this way it is a mutable mobile. The fact that the pump continues to *work* in spite of these changes and according to users' interpretation of its efficacy prompts de Laet and Mol (2000) to question what 'working' means:

> (T)he question as to whether or not the Bush Pump actually *works*, as technologies are supposed to, can only rarely be answered with a clear-cut 'yes' or 'no'. Instead, there are many grades and shades of 'working': there are adaptations and variants. Thus the fluidity of the pump's working order is not a matter of interpretation. It is built into the technology itself (2000:225).

Crucially, this means that even when the pump fails to deliver clean water, de Laet and Mol (2000) show how it still *works* to provide water, bring communities together and educate them about health. They draw attention to how it operates in ways intended and unintended by its original designer. It is strong and durable, not because it enforces a defined and narrow use on people but because it is 'adaptable, flexible and responsive' (2000:226). The central tenet of their argument is the idea that a technical artifact can be resilient and reliable because of its ability to change, not in spite of it. They argue:

> (...) we hope to contribute to an understanding of technology that may be of help in other contexts where artefacts and procedures are being developed for intractable settings which urgently need working tools. Because in traveling to 'unpredictable' places, an object that isn't too rigorously bounded, that doesn't impose itself but tries to serve, that is adaptable, flexible and responsive - in short, a fluid object - may well prove to be stronger than one which is firm (2000:225).

A common STS approach to this type of inquiry involves an analysis of 'boundary objects', which Star and Griesemer define as 'both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites' (1989:46). However, what emerges in ANT literature is the notion of knowledge as performance and practice as opposed to the unyielding presence of a fixed, solid object (Mol 2002; Law and Singleton 2005). Writing about alcoholic liver disease, Law admits, 'we slowly came to believe that we were dealing with an object that wasn't fixed, an object that moved and slipped between different practices in different sites' (2005:79). Law and Singleton emphasise how knowledge is 'enacted into being' and how this ontological move shifts attention away from multiple interpretations of objects to the objects themselves (2005:334). They describe how ANT has viewed knowledge objects as '*regions* or volumes', as '*networks*' and 'objects as *fluids*' and argue for a fourth possibility -

'objects as *fires*' (2005:335 emphasis in original). These, they explain, 'are energetic and transformative and depend on difference between (absent) fuel or cinders and (present) flame' (2005:344). Like fluid objects, fiery ones change shape, however this change is not gradual but sharp and characterised by rapid jumps and discontinuities and absences and presences. They argue that 'we cannot understand objects unless we also think of them as sets of present dynamics generated in, and generative of, realities that are necessarily absent' (2005:343).

Overall these ANT studies reveal the flexible, multiple, unstable, fluid and firery characteristics of networks and systems. Rather than erasing discordant actors and disruptions, they embrace the ambiguity and uncertainty of co-existing realities. In doing so, they illustrate alternate ways of knowing that resist ordering into neat, sequential and hierarchical accounts.

In this section I also wish to briefly make the link between Latour's later ANT work on engineering, infrastructures and accounts of the urban with my study of cultural practices of a community wireless network group. Specifically, Latour's (1999) analysis of 'Aramis', an automated French train system that was designed and developed but ultimately failed to be produced, draws attention to the way objects and knowledge are passed around in more or less disorderly ways. The hybrid style in which Latour writes also bears mention in relation to my interest in alternate forms sociological knowledge.

Guided by ANT, in 'Aramis' Latour emphasises the imperative to account for human and non-humans in the process of understanding the role of a new technology in social worlds. He argues that 'an object that is merely technological is a utopia' and cannot be separated from the social world (1996:viii). Instead, he seeks 'to show researchers in the social sciences that sociology is not the science of human beings alone – that it can welcome crowds of nonhumans with open arms, just as it welcomed the working masses in the nineteenth century' (ibid). To do this, Latour takes an innovative approach. He discounts science fiction as 'inadequate', fiction as 'superfluous', realism as 'misleading' and journalism as too divisive, on one hand 'popularising technology' and on the other 'denouncing its politics' (1996:ix). Instead he devises a hybrid genre called 'scientification', a cross between narrative and history, which entwines the voices of multiple humans and non-humans involved in the project spanning almost two decades, from 1970 to 1987.

What this means is that the story of 'Who killed Aramis?' is told by many stakeholders in the project: engineers, politicians, company executives, as well as a sociologist and his

young engineering student who act as detectives investigating the failure of the project. Aramis, too, delivers a passionate plea to be born. The story that unfolds through interview transcripts, policy documents, media reports, design documents and narrative prose reveals the multilayered, complex and indefinite nature of a technology in the making, and one that is undeniably embedded and intertwined with human activities and culture.

The central tenet of this 'scientification' is the absence of a single and straightforward answer to account for the failure of Aramis. Everyone interviewed in the book offers forth their personal perspective on events and very few of these accounts match up. As a result, the sociologist and his young assistant have immense trouble trying to piece together this jigsaw. Overall, what emerges in Latour's account is that this complex technological system did not fail because it was technology unfeasible, politically doomed or culturally inappropriate. It failed because it was not loved. Latour, as the young engineering student, explains:

> They abandoned technology while thinking that it was going to be finalised all by itself, that it was autonomous, that they'd see how things worked out afterward, that it had to be protected from its environment (1996:287).

The idea that constant negotiation and attention is crucial to the success of a new technology is highly relevant to my study of backyard technologists. Given the group is comprised of volunteers committed to making a WiFi network in their spare time, using their own resources, materials and in many cases homes, this will be area explored in more detail throughout the thesis.

What I hope is made clear by the review of Latour's (1996) work on Aramis and select ANT literature is my awareness of, and interest in, opening up less conventional ways of looking at human and non-human networks, knowledge construction and technological development, all of which provide insight into the character and culture of backyard technologists in suburban Australia. The next and final section explores the contribution my study offers to a small but growing body of literature concerned with other versions of internet infrastructure.

III. The Australian cultural context and attending practices

> To study the internet in a critical temper is important for many reasons, not least to understand where we place ourselves in our society and where we fit in the world, and to provide us with resources to critically engage in the knitting of such technology, into our future lives as we debate the meanings of Australian national, regional and international identities in a networked economy (Goggin 2004:9).

Goggin (2004) argues that the internet is firmly embedded in distinctive social, spatial and cultural environments, and if we are to understand it we need to examine the many forms it takes in different contexts. This perspective, emphasised in studies of the internet in Trinidad (Miller and Slater 2000) and Japanese internet and mobile phone cultures (Ito et al 2005), contributes to emergent sociological interest in alternative versions of the internet in contexts outside Europe and the U.S.

Miller and Slater (2000) argue that while the discipline may not have benefited from early accounts of the internet as placeless, it 'can gain hugely' in comparisons between places (2000:10). Their ethnography approached the internet as an everyday social accomplishment made up of material arrangements, relationships and a local understanding and found it formed a nucleus of Trinidadian culture. What they were studying was not 'people's use of 'the internet' but rather how they assembled various technical possibilities that added up to *their* internet' (2000:14 emphasis in original). In this context the internet is not a 'monolithic or placeless "cyberspace" or a virtual experience separated from physical place, rather it was deeply embedded in Trinidadian culture and it was simply part of being 'Trini' (2000:1). Drawing on this study, Meikle argues that 'in this sense, perhaps, the internet has not yet been invented, but rather is always being invented and reinvented in each new context and situation' (2004:75).

Goggin (2003, 2004, 2004b, 2007) presents a similarly distinct view of the internet from an Australian perspective. He points out the imperative 'to attend to its particularities' in order 'to understand where we place ourselves in our society and where we fit in the world' (2004b:9). He charts the development and demise of *Pegasus*, one of the earliest ISP's in the country, set up by a collective united in environmental protest culture of the 1980s. Its original design was predicated around activist networking and it was located in Byron Bay on the east coast of Australia, known for its liberal politics, art, surfing and DIY culture. The story of *Pegasus* is important in the telling of Australian internet history because it provides a useful reminder of the role DIY groups play in the development of new technologies.

> Pegasus and the other organizations whose efforts established the global facility we enjoy today can also remind us that the internet is not just some effort of the governments that began

> in the Pentagon, or some technical facility that ought to be managed by the people who created it. Rather, it is the sum of the efforts of all its contributors. When it comes to the internet of tomorrow, we cannot leave it solely to governments and technicians. The strength of the internet is the people at the ends of the lines, not a central structure. We can all make a difference being involved (Goggin 2004b:53).

As I indicated earlier in this chapter, there is a small and growing body of work around WiFi but it tends to focus on US and UK wireless cultures. Goggin and Gregg argue that 'while there has been a great deal of academic, community, government and industry work on digital technologies in Australia, and much important critical and scholarly work in particular, in our minds wireless technology and cultures have not been given the sustained attention they deserve' (2007:43). Drawing on these literatures, this thesis takes the view that local versions of WiFi might present different ways of thinking about possibilities of development and use in other places. It is my argument that another version of WiFi will become visible if attention is paid to Australian cultures of WiFi, and in particular those of backyard technologists. Just as Miller and Slater's close engagement with the specificities of Trinidadian culture revealed a Trinidadian version of the internet, it holds that attending to the nuances and texture of Australian suburban culture with its unique set of Australian materials, landscapes, fauna, flora, weather and people will reveal an Australian WiFi.

Locating 'real' Australia in the 'vast and unexplored suburban tundra'

This study is located in suburban Australia. Despite the central positioning of the desert, the ocean, the bush and vast open spaces, 'going bush' or 'walkabout' in cultural imaginaries of tourism advertisements and global performances of Australian-ness[13], the practical reality of everyday living is significantly more coastal and residential. To better grasp the idea of suburbia in Australian culture and the role it plays in shaping technological infrastructure it is important to understand a little about Australia's population distribution. Only twenty one million people live on a continent that covers almost eight million square kilometres. This means there are not quite three people for every square kilometre in Australia (ABS 2008). For comparison, the population of the UK is just over sixty million, three times Australia, on an island thirty two times smaller than Australia, which means that for every square kilometre there are two hundred and fifty one people[14] (NSO 2008) (Fig. 4). Despite this vast

[13] The 2007 Australian Tourism Commission campaign featured remote and isolated places of extreme beauty - the outback, the bush, Uluru, the barrier reef, the seven sisters. In 2008, Baz Lurhman's version featured stressed unhappy residents of densely populated cities of New York and Shanghai, reinvigorated after going 'walkabout' in remote Australia. The 2000 Olympics Opening and Closing ceremonies represented Australian history with images of the bush, the desert and the beach (Australian Tourism 2008). Advertisements regularly use images of the bush and the beach to symbolise the nation's desire to escape (See Telstra 2008).

[14] UK population is 60, 975,000 (NSO 2008) and the UK total land mass is 242,900 square kilometres.

landscape, four out of every five Australians live in urban cities located within six miles of the coast (ABS 2004). The fact that the majority of Australians inhabit a tiny coastal edge of this massive land mass means that 'whether we like it or not, the suburbs and suburban life reflect and reproduce stories of being Australian' (Elder 2007:298). As much as Australian's imagine themselves otherwise, suburban living is a quintessential characteristic of being Australian (Fisk et al 1987; Ferber et al 1994; Johnson 1994; Webster 2000; Elder 2007; Turnball 2008).

The Australian reality might be suburban but for many it is, as Weber writes, 'both their greatest aspiration and their worst nightmare' (1992:24). Similarly, Elder points out how 'the suburbs have been vilified, lampooned, eulogised and idealised' (2007:298). This ambivalent relationship is in part fed by the *Great Australian Dream*, which mythologizes owning a piece of Australia which is most often packaged as a house with a small yard or increasingly, a compact flat in an apartment building. The fact that Australian culture draws more on the dramatic and untamed image of the outback and the people who live there and much less on the unremarkable everyday aspects of suburban existence, suggests we know very little about 'real' Australia. Turnball (2008) writes:

> By the time of Australian Federation in 1901, almost 70 per cent of Sydney's population were living in the suburbs; a statistic that suggests that despite prevalent and enduring images of the bushman and the ocker, the 'real' Australia was, and still is, more likely to be located in what Barry Humphries has described as Australia's 'vast and unexplored suburban tundra (2008:15).

Moreover, it is evident that what Australians do know they tend to treat with contempt and cynicism. Writing about one of Barry Humphries' enduring characters Dame Edna Everage, otherwise known as the average suburban housewife, and two more recent suburban comics, Kath and Kim, Turnball argues that suburbia remains a resource for comedy because it draws on a 'long tradition of anti-suburbanism' (2008:15). This is all the more incongruous considering, as MacKay points out, it is not the case that we have gradually become suburban, but that 'we've never been a rural people' (cited in Marks 2004). He explains:

> We continue to embrace the rural mythology, which is really powerful in terms of Australian identity. In a sense, the yard has kept us in touch with the land (ibid).

It is therefore all the more unusual that 'we do not celebrate the virtues of suburban living' (McKay 2008). One reason why suburbia is vastly underestimated, overlooked or vilified relates to its mundane and taken for granted presence in everyday life and, like STS literature on marginal technologies, offers insights into how it serves 'the reproduction of local social configurations' (Michael 2000:3).

A recent preoccupation with real estate and house renovation in Australia, signalled by ever upward spiralling house prices and characterised by popular television programs such as *Burke's Backyard* and *The Block,* points to a new interest in suburban living. Elder (2007) argues that the economy and popular culture are starting to shift the deeply embedded ambivalence towards suburbia. In these reworkings, suburbia is viewed as a product of, and a landscape for, resourceful and imaginative endeavour. Although, this is an example of DIY as home improvement, it provides an example of shifting suburban attitudes. A recently funded Queensland University of Technology research project titled *Creative Suburbia*, provides another. This project aims to explore 'whether more of Australia's creative workforce is located in the outer suburbs of Australia's cities than is commonly assumed in the creative industries literature, which has tended to emphasise the unique powers of inner-city 'buzz'' (Flew 2008). The recognition of the role of suburbia in reflecting and mediating everyday life paves the way for a study of backyard technologists who both inhabit and enrol suburbia in their engagement with WiFi.

My point here is that although suburbia is easy to overlook because it is right in front of our eyes, it functions as a vital component of everyday life in Australia and therefore supports the idea that studying it from one of its central points – the backyard – is not usual. Moreover, as I will explain in the next section, in relation to shed culture, backyards offer vantage points into ICT relationships.

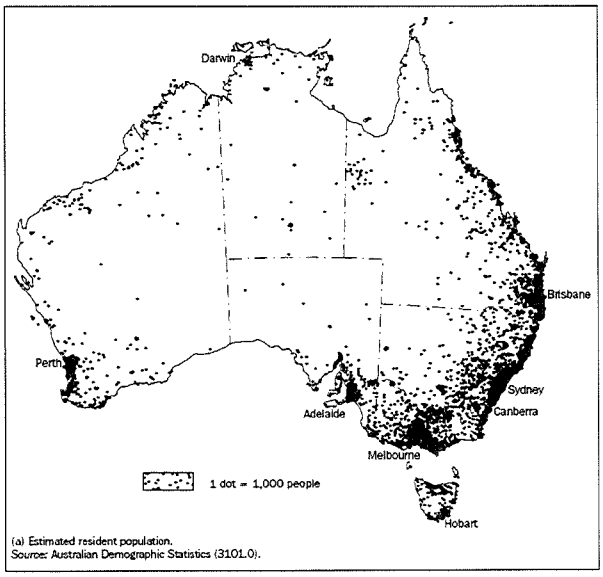

Fig. 4. Map showing the population density of Australia (ABS 2008).

Suburban Australian backyards and shed culture

Despite the prevalence of suburbia in Australian cultural geography, backyards do not play an important role in sociological or cultural theory literature. Although there is a wealth of useful material for when it comes to talking about suburbia (Fisk et al 1987; Ferber et al 1994; Johnson 1994; Webster 2000; Elder 2007; Turnball 2008), there is a dearth about backyards. It is an area of sociological literature I hope to fill with this study about backyard technologists in suburban Australia.

There is however more work that has been undertaken about Australian sheds, and as a significant portion of wireless work takes place on backyard sheds and suburban rooftops, it holds that a brief review of shed literature will provide relevant insights for my thesis. Despite his ironically titled position of Director of the Institute of Backyard Studies (IBYS), Mark Thomson (2002, 2002b, 2006, 2007, 2007b, 2008) has written at length, and in a scholarly vein, about men, innovation and Australian shed culture:

> Sheds are an integral part of Australian life. No other nation values them as we do. Despite this, our sheds, modest from the outside, yet glorious on the inside, have never really been recorded or their many purposes explained (2002:2).

Sheds take many shapes and sizes and shelter a diverse array of tools, materials, machinery and other random things. They are not defined by the specifics of what they hold or even what they are used for but rather in what they enable. Sheds are closely linked to an Australian DIY ethos of practicality and ingenuity and enable a different view on suburbia: 'In the shed, the rules are different. Here, chaos is allowed to reign, asserting its creative force in wayward contrast to the suburban order all around' (Thomson 2002:2–3).

Bell and Dourish also view the shed as a significant part of a suburban Australian culture and importantly, for this thesis, make connections between sheds and ICTs: 'So what might the shed, both real and imagined, have to say to technologists or those engaged in the production of new information and communication technologies' (2006:376). They view the shed as a lens for understanding suburban technological frameworks. Rather than looking inside the shed, they look at the larger cultural context in which the shed is located. They argue that the shed provides a privileged viewpoint on domestic practices, enabling new ways to think about socio-technical relationships and sites of encounters between new technologies and existing domestic ecologies.

Both Thomson (2002, 2002b, 2006, 20007, 2007b, 2008) and Bell and Dourish (2006) signal the importance of mundane, ordinary and otherwise overlooked architectures of suburban

life. They propose that looking inside as well as outside these Australian spaces provide insights on local cultural practice and new technologies. Even Thomson, whose respondents primarily use sheds to tinker on cars, bikes, agricultural machinery, wood-turning and the brewing of beer, makes links between sheds and technology: 'Several of the stories hint at a new future for the shed-owning type of person: the computer. The virtual shed is with us now' (2002:255). Relating this to Goggin and Gregg's call for research that attends to the 'specificity of the technologies and their settings' (2007:43), it is my hope that a study about WiFi that locates itself firmly within the Australian backyards might provide new ways to see conventional technological frameworks and infrastructures.

A final important aspect of this literature concerns gender identity. Both Thomson (2002, 2002b, 2006, 20007, 2007b, 2008) and Bell and Dourish (2006) recognize sheds as spaces where masculinity is produced as a counterpoint to the narrative of the home as a feminised space. In this thesis, I view backyards as masculine spaces as well. Moreover, as will become evident, the Australian 'barbie' or barbeque features strongly throughout and it too is renown for producing masculinity. Because these spaces and practices are prominent, gender is an underlying thread in this study of WiFi made by backyard technologists in suburban Australia.

Does Australian WiFi 'stick' to Australian men?

The STS work that my thesis draws upon, located in the disciplines of science and engineering, is predominantly 'gender-blind' (Faulkner 2003:91). Despite focusing on disciplines renown for being male dominated, neither Latour and Woolgar (1979) in science or Henderson (1999) in engineering make anything more than passing reference to gender relations. More recent STS studies I reference also deliberately choose not to focus on gender. Mol (2002), for instance, notes uses the generic 'he' instead of 'the doctor' because all her surgeons and internists were men except for one female pathologist, yet points out that gender is not her concern. She writes: 'Yes, this is a fading historical moment. The professional is undergoing a rapid gender change. But that is another story. One more complication left out here' (2002:2).

Guided by these ethnographies, gender was not my initial concern either. However, in the field it became too significant to ignore. Out of seventy people involved in Air-Stream there were only three women, of which I was one. Although I was aware of this imbalance from early interviews with Ron and Tim in January 2006, it was not driven home until I attended my first meeting in June 2006 and walked into a room full of men. This is not only because

relevant literatures did not deal with it, but because unlike what is known about the exclusive male dominated areas of science (Traweek 1988; Wacjman 1991; Harding 1991), engineering (McIlwee and Robinson 1992; Faulkner 2000, 200b, 2003, 2007) and architecture (Fowler and Wilson 2004), I wanted to believe the inclusive rhetoric of the network on Air-Stream's website:

> Air-Stream Wireless is a non-profit community group who use wireless in combination with free and open source technologies to deploy a wide area network (WAN) that supports community participation, local content and communications. (...) Our members are people from all walks of life and ages including enthusiasts, IT professionals, radio amateurs, educators and everyday people (Accessed 06.07.06, Available at: http://www.air-stream.org.au/).

However, as my experience revealed, the 'everyday people' of whom this mission statement refers are in reality 'men'. Unlike other volunteer not-for-profit groups such as the Australian Men's Shed Movement[15] or the Country Women's Association of Australia[16] which render clear the nature of their gender domains, Air-Stream emphasise 'community' and the diverse skills and interests of its membership that come from 'all walks of life'. Yet, given the overwhelming incidence of male members, this was clearly not the case. Despite the fact that the group lowered traditional barriers to entry that traditionally inhibit women from entering IT sectors, such as holding meetings in the local public school, not requiring membership or advanced technical skills to participate, and emphasising the sociality of the group, WiFi still appeared to be 'technology as masculine culture' (Wacjman 1991). Therefore, the practice of representing Air-Stream as a *community group*, and not just a men's group, raises a number of interesting and complicated questions: What is it about WiFi that attracts mostly men? What is inherently masculine about the way the group makes WiFi? And what, if any, influence does this have on how WiFi is represented?

In his book on rare trades in Australia, Thomson's (2006) explanation for the lack of women skilled in traditional hands-on technical professions (only eight in fifty four case studies) echoes what has been written in feminist STS. This includes structural barriers that limit training and access, lack of recognition when women were involved and biological excuse that women just were not interested in such stuff. Rather than locating the blame on women for being 'uninterested' many writers question science and technology, examining how these disciplines and artefacts might be shaped otherwise to accommodate women (Cockburn 1983; Harding 1987, 1991, 2004; Faulkner 2000, 2006, 2006b, 2007). Faulkner (2000), in particular, has done much to tease engineering from masculinity:

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[15] For more information about The Australian Men's Shed Movement see http://wwwmenssheds.com.au
[16] For more information about The Australian Country Women's Association see http://cwaa.org.au

> My own project in this article is to encourage people to get "inside the belly of the beast" of technological design, to examine how gender "sticks" to engineers involved. Bluntly put, I believe engineers represent an important research focus for feminist technology studies because they are powerful instantiations and symbols of he equation between masculinity and technology. A better understanding of engineering practice and how engineers tick should contribute to a better understanding of how that equation works. It might also yield fresh insights into why there are so few women in engineering, though this is not my first concern in this article (2000:89).

Like Faulkner (2000), this is not a study that asks where are the women but rather why does WiFi 'sticks' to more men much more than it does to women. Ignoring the high incidence of men in a community group that is open to both men and women, has the effect of accepting and naturalising WiFi technology as being for men only, rather than questioning why this is the case. This is not lessened because it is 'just a hobby'. As Haring (2004) observed in her study of ham radio operators, many hobbyists used their involvement in amateur groups as training for and access to the radio profession and associated industries. In exploring the role and importance of culture that surrounds WiFi, I argue that gender should not be ignored.

Conclusion

This thesis seeks to understand the nature of the visual culture of WiFi made by backyard technologists in suburban Australia. Through an analysis of the development and use of one specific wireless digital technology in one particular location this study contributes not only to the literature within STS on the role of visual culture but also seeks to address the lack of attention paid to the study of technological infrastructure and to visual study more widely in sociology. It aims to make central the study of visual culture in the study of ICTs and also call for recognition of DIY innovation in the context of STS. Importantly, this thesis sets out to intervene in conventional assumptions of technological innovation in large-scale institutional settings in the UK and US. I hope to introduce another vision of the technology made by backyard technologists in mundane and suburban locations. In this chapter I have established the relevancy of a sociological study of the visual practices of backyard technologists in suburban Australia. The next chapter will examine in detail the epistemological and methodological implications of this work.

Chapter Three.

Researching Australian backyard technologists

This chapter details how I approached a study of backyard technologists in suburban Australia. It begins by introducing Air-Stream, the group under study, its location and respondents who feature throughout this thesis. It then outlines the research design and highlights some of the epistemological, methodological and practical issues that shaped my fieldwork. I discuss the key characteristics of what Hess (2002) calls 'second generation' STS research and the implications for understanding the visual culture of a new digital technology. I also address the challenges of participating in while studying the visual culture of others and how this relates to existing notions of the visual in sociological knowledge.

Air-Stream – A not-for-profit community WiFi network

Air-Stream was selected as a site of fieldwork for practical and theoretical reasons. Not only was Air-Stream operating in the suburbs of a major Australian city but they also had a rich visual culture. My decision was initially informed by Air-Stream's regularly updated and comprehensive website that features maps, photos, diagrams, a discussion forum, comprehensive 'how to' guides and technical documentation as well as links to other local and international community groups. Internet researchers have drawn attention to the sociological challenges of the fleeting life cycle of websites (Kotamraju 1999) and if a WiFi community website is no longer updated or does not exist at all it is a clear indication that the group behind it is no longer operating. Air-Stream's website, which was updated daily and sometimes several times a day, indicated a thriving community. Guided by STS literature that recognises visual representations as an important locus of knowledge, the website also clearly identified Air-Stream as group vigorously engaged in the making of WiFi.

Because I wanted to conduct research across varied contexts, importantly not all Air-Stream's WiFi activity takes place online. Members meet face-to-face for annual Open Days where they demonstrate the network to new people, hold antenna 'shoot outs' to test the efficacy of home-made devices, run monthly meetings at the local public school as well as regular antenna installation and maintenance sessions. Additionally, the group has been steadily growing in size for six years, several founding members remain involved and the group openly welcomes new people, thus indicating the presence of a wide range of experience and knowledge in the network.

In January 2006, I contacted the Air-Stream committee using email addresses found on their website with an outline of my study and a request for a meeting. At that time there were 70 members of the group and eight in the committee that helped guide, plan and organise the

group. Ron, the secretary and self confessed 'PR person' was the first to respond and set up an initial meeting with himself and Tim, the chairman and founding member in mid January. He was often the first person to respond to media enquiries and questions from new people and even though the website features a wiki which enables multiple people to collaboratively add and edit content, it was primarily managed by Ron, who good naturedly 'hassled' members for 'stories' on a regular basis.

I visited Adelaide in January and March 2006, spent five months observing the community online from London and ten months, from June 2006 to March 2007, lived full time in the city observing and participating as an Air-Stream community member. I returned to Adelaide twice more in 2007, in June and December, and I continue to correspond with Air-Stream members by email, my research weblog, mobile text messages, *flickr* and *facebook*[17]. On a practical note, being an Australian national meant I had no issue gaining entry or living in the country for a long period of time.

During my fieldwork I lived on the north-west fringe of the city centre in a stone and brick bungalow, typical of the suburban architecture of the area, in easy cycle commute to the majority of meeting points, members' houses and other antenna sites. I was given 'honorary' membership, which included all membership privileges, such as access to members' personal information on the website and an email account through which I learnt about upcoming activities. I did not have the right to vote at the end of year annual general meeting (AGM). It is important to note however, and will be discussed in Chapter Four, that membership is not a pre-requisite for viewing or contributing to the website or attending the many group events. However, for me, it provided access to even more of the group's visual representations. I regularly attended monthly meetings, antenna installations, maintenance and tinkering sessions and public events such as Software Freedom Day, a public OSS event held at a local community centre, in which Air-Stream demonstrated their WiFi network to potential new members. I also attempted to get connected to the network from my house, and although ultimately unsuccessful it provided a means for understanding the process through which new antennas are linked into the infrastructure and the network expands across the city. Importantly, and will be discussed in detail in Chapter Seven, it illustrates how being technically disconnected did not prevent me from participating in the group.

[17] See http://www.studioincite.com/makingwifi, http://www.flickr.cm/photos/katjung, http://www.facebook.com.

Suburban Adelaide

The Air-Stream community wireless group inhabits the suburbs of Adelaide – interestingly, Adelaide is more suburban than any other Australian capital city due to the size of its residential lots and small dense city centre. It is also significantly different in its history and urban-planning than other Australian capitals. With a population of 1.1million, Adelaide is Australia's fifth largest capital city. Seventy Two per cent[18] of the population of South Australia resides in the capital city, the highest ratio of all Australian states except Western Australia[19] (ABS 2006b). Founded in 1836 Adelaide was Australia's first free settlement[20], and designed by Colonial Light, the first planned city in Australia. The state also has distinct older style architecture; houses are predominantly single storey local stone constructions with large backyards.

In fact, Adelaide's residential footprint differentiates itself from the rest of Australia. Hall's (2007) comparative study of old and new suburbs signals the Australian backyard is shrinking everywhere *except* Adelaide. According to Hall, an average house, which once occupied thirty per cent of an average suburban block, can now take up to seventy one per cent[21]. The impact of this expanding footprint is social, visual, environmental and cultural. He argues that people are spending more time inside, use more energy to cool their houses and consume more resources than people with outdoor space. A larger house, he argues, fosters an indoor mentality. An exception to this otherwise nationwide shift is found in Adelaide suburbs. Unlike Brisbane, Perth, Sydney and Melbourne[22], houses are not expanding and backyards are not shrinking to the same extent.

Building on what I previously argued about backyards comprising an essential part life in suburban Australia, Hall's (2007) study on the distinctiveness of Adelaide's backyards serves to further support my choice of field site for the study of backyard technologists.

Who's who in Air-Stream's WiFi network

In addition to Tim and Ron, I spent most of my time in the field with thirteen other individuals involved in the group. Eleven were members and three were not. However as will become clear in the following chapters, membership in the group is neither

[18] At the 2006 census, the total population of the state of South Australia was 1,089,728 (ABS 2006b)
[19] 55.7 per cent of the population of New South Wales live in Sydney, 42.9 per cent of Queensland live in Brisbane, 70.3 per cent of Victoria live in Melbourne, 73.5 per cent of Western Australia live in Perth.
[20] Unlike all other Australian capital cities, convict labour was not used to construct the city of Adelaide.
[21] Houses in the new suburb of Hendra, Brisbane had plot coverage of 58 per cent to 71 per cent.
[22] Hobart was not included in Hall's (2007) study.

straightforward nor clear-cut. These people invited me to installations and maintenance events, welcomed me into their homes, showed me their hand-made antennas, taught me how to search for wireless signals and regularly explained complex WiFi jargon. Together they represent a cross section of the group in terms of length of membership, age, experience and life-stage. To introduce my respondents I draw on how Duneier (1999) maps the table positions of the book-sellers and pan-handlers in the streets of New York, prior to telling each of their stories. Using an annotated plastic sheet over Air-Stream's network node map, my version of this technique affords a way of locating respondents to relation each other, the city and the network (Fig. 5).

Like the website, the network node map is an important Air-Stream representation made and distributed by Ron in multiple forms; on the website, folded A4 sheet brochures and A3 sized posters for distribution at meetings and other public events. This, my second version (I collected five during my fieldwork), was distributed at a meeting in September 2006. It has been regularly updated since then with the addition of many new nodes and the removal of others. Comprising a schematic system of dots and interconnecting lines over a bird's eye, two-dimensional street map of the city of Adelaide, the map provides a view of the network that is otherwise visually impossible. Dots indicate core nodes or what members call 'backbones' through which the bulk of data is trafficked. Up to thirty smaller 'client' nodes connecting to these larger points are not mapped for the sake of clarity. Lines represent the connections between two points that are able to 'see' each another along a line of sight (LOS). On the map, the names of nodes are written in black. For the most, part they reference the suburb in which they are located with the exception of those attached to radio or TV towers. As per ANT literature, this map plays an important role in the heterogeneous network and therefore warrants introduction in this section. I return to it in more detail in Chapter Five.

In line with sociological guidelines that advocate respecting and protecting the privacy of respondents, I have changed all respondents names (Heath and Luff 1995; Newell 1995; Procter 1995). The name of the group however is unchanged, as I felt the location in suburban Australia is critical to the central argument about Australian backyard technologists. Duneier (1999) is one of only a few sociologists who resist this practice for reasons relating to accountability.

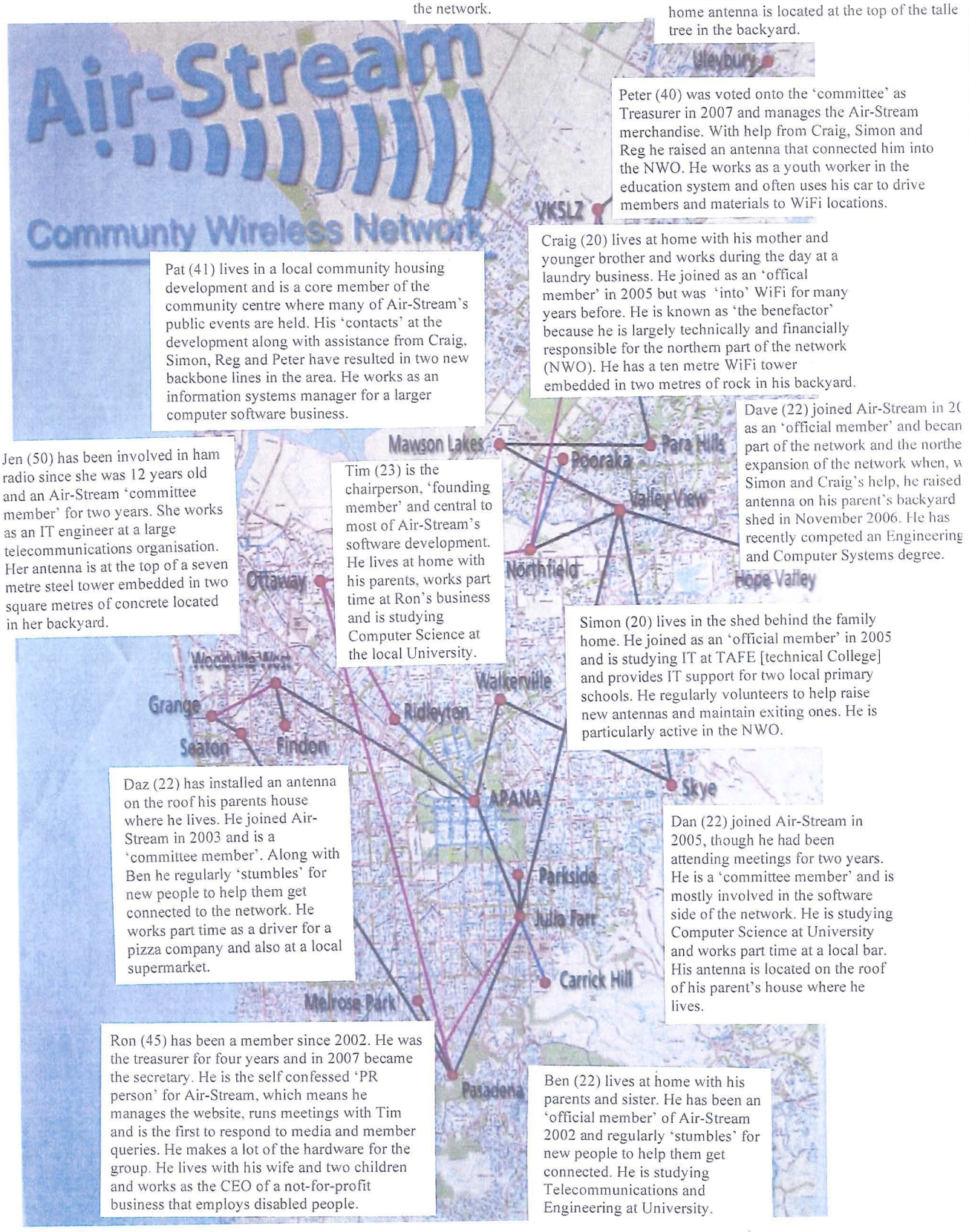


Fig. 5. The Air-Stream Network Node map - (Distributed at an Air-Stream meeting 16.09.07).

Kerry (33) is an 'official member' and Jane (43), a self confessed 'tourist', have been attending meetings for a year but cannot get connected to the network from their rented house. They are looking to buy and on their list is one with a 'good view'. Kerry works in IT at a local University and Jane is a freelance graphic designer. They are both heavily involved in local OSS events.

Jason (24), along with Tim, is one of the 'founding members' of Air-Stream. During 206-07 he irregularly attended meetings and events because he had a new jo at his father's winery and moved house which involve moving his antenna. His last job was as technical support for a local ISP. He is currently disconnected from the nework.

> Sociologists say that they use pseudonyms to protect the privacy of the people they write about: journalists insist that they must name their subjects to give truthfulness to the accounts and assure the reader that these are not composite characters or made-up characters. I have decided to follow the practice of the journalists rather than the sociologists (1999:347).

As per my argument in Chapter Two, about the importance of the Australian cultural context and attending practices in the construction of ICTs, I felt it critical to firmly locate the backyards I was studying in a specific place. I am also aware that the 'issue of identity/anonymity is more complex and less predictable than it might at first appear' (Grinyer 2002:1). In the event I publish articles from this thesis, for example, I will discuss with respondents whether pseudonyms are appropriate or if they would rather I use their real names.

Now that I have introduced the group and located the network, I will explain in detail how I approached the study of backyard technologists in suburban Australia starting with an outline of my ethnographic practice.

Practical epistemologies – Ways of seeing and knowing visual culture

My study of WiFi by backyard technologists in suburban Australia uses ethnographic methods. As discussed in the previous chapter, STS literature has shown that visual culture is a distinct way of knowing through the experience of visual materials (Latour and Woolgar 1979; Latour 1990; Henderson 1999). In the context of science and engineering, inscriptions and conscriptions are considered knowledge producing objects wholly situated in local practices. In order to ground science, which until that point had been considered universal and placeless, Latour and Woolgar (1979) went into the laboratory to study what scientists did in their everyday activities. This strikingly different approach meant, 'instead of using large-scale entities to explain science and technology as most sociologists of science do, we should start from the inscriptions and their mobilisation and see how they help small entities become large ones' (Latour 1990:56). Similarly, in engineering Henderson found that: 'To understand the visual culture and technical work of engineering and design, we must observe the daily processes involved in the work itself' (1999:1). As a result, Latour and Woolgar (1979) and Henderson (1999) approach the study of visual culture using qualitative methodology and ethnographic methods and in this thesis, I take a similar tact. Using ethnographic methods I examine how role and importance of visual culture that surrounds WiFi by backyard technologists in suburban Australia.

Ethnography is an ideal approach for the analysis of visual culture because it combines a range of qualitative methods as a way of gaining an in-depth understanding of a culture from the point of view of its participants (Fielding 1993; Hammersley and Atkinson 1996; Fetterman 1998). According to Hammersley and Atkinson, 'it involves the ethnographer participating, overtly or covertly in people's daily lives for an extended period of time, watching what happens, listening to what is said, asking questions – in fact, collecting whatever data are available to throw light on the issues that are the focus of the research (1996:1). This means an ethnographer gains a nuanced understanding by immersing herself in the social, cultural and physical worlds of a particular group and attempting to see the world through their eyes. The difference between a layperson and an ethnographer lies in constantly comparing the unfamiliar with the familiar in an attempt to generate 'a self-conscious awareness of what is learned, how it has been learned, and the social transactions that informed the production of such knowledge' (1996:101). Importantly, for my study of mundane and ordinary spaces in the form of suburban backyards and a technology that is commonly considered an infrastructure and therefore invisible, the subject in focus does not have to be especially foreign to offer a unique view. As Henderson notes: 'No matter how exotic or commonplace a culture might appear, *every* group has special characteristics and idiosyncratic behaviours that an ethnographer must respect' (1999:2, emphasis in original).

From the outset, I joined Air-Stream as an overt researcher and volunteer member. This meant they were aware of my research project when they accepted me in the community. The position of the researcher as inside or outside the social group in focus is particularly important for researchers of visual researchers. Lofland and Lofland note one of the initial difficulties in observing and participating is 'getting in' to a group or site of study, which they define as 'gaining the acceptance of the people being studied' (1984:20). Although it would have been possible to conduct a documentary or semiotic analysis of engineering and scientific representations from the outside, Latour and Woolgar (1979) spent two years observing in the laboratory at the Salk Institute and Henderson (1999) worked as a technical writer, attending design meetings and observing daily interactions between engineers in two U.S firms. These inside positions provided them with intimate access to the integral practices and associated activities unobtainable to a distant outsider. This is particularly relevant to my study because although it might be possible to undertake a semiotic study of the visual materials that surround WiFi, it would not address my question and would not make available the type of data that comes from engaging with the visual representations that shape and are shaped in these contexts. To try to dig deeper into the surface of images,

in absence of the people, places and conditions in which they are made and used could in fact produce greater ambiguity.

Unlike other ethnographies whereby the researcher has to remind respondents of their status (Hine 2000; Silverman 2004), there was little ongoing ambiguity about my constant presence as a researcher for a number of reasons. I was the youngest woman at thirty three years of age (there were only two other women out of seventy in the group and they were forty three and fifty years old), I was new to Adelaide and my knowledge of wireless was limited compared to other members. Also, despite being an Australian national, I had a discernable accent from living in London for eight years. This only served to exacerbate my foreign-ness. On a few occasions, members had to be reminded that I was in fact more local than I sounded.

> *Daz jokingly suggests to me it (the thefts) might have something to do with the fact that 'we are Australian' and that 'we started out as convicts'. Ron overhears him and reminds him that 'Kat is from Newcastle' [New South Wales] and 'not the UK'. (Field notes 26.07.06)*

This interaction reveals my multiple identities in Air-Stream; an Australian national, woman, cyclist and, given members' proclivity for barbeques, vegetarian. The fact that people regularly explained social, technical and cultural particulars worked advantageously for me in gaining an understanding of the group and simultaneously decreased the danger of one of the key problems of ethnographic enquiry - 'going native' (Fielding 1993). A major concern for ethnographers lies in getting too close to the field site to the point of losing critical distance.

More often called a craft than a technique, there is no single design for ethnographic study (Silverman 2001, 2004; Harris et al 2003; Bryman 2004). Researchers of science studies have incorporated ethnomethodological approaches in their work, which emphasise attentiveness towards 'people's methods' for interacting with each other and making meaning in the world around them (Latour and Woolgar 1979; Knorr Cetina 1981; Lynch 1985). Researchers of technology studies, as outlined in detail in Chapter Two, have drawn on ANT, a perspective that recognises the agency of non-humans as well as humans in heterogeneous networks (Callon 1986; Latour 1987, 1990; Henderson 1999; de Laet and Mol 2000; Mol 2002; Law and Singleton 2005). Given the presence of trees, birds, thieves, members, families, backyards, websites, sheds, antennas, the weather, email, phones, barbeques, cars, houses, rooftops, sticky tape, cameras, maps and computers involved in the making of WiFi, it is clear that ANT also emerged as an important part of this ethnography.

Multi-sited ethnography

Another aspect of multiplicity concerns the number and diversity of field sites that emerged in my ethnographic engagement with backyard technologists. What marks a significant departure to Latour and Woolgar's (1979) and Henderson's (1999) ethnographies is where my research is located. Conventional ethnography involves the study of a specific social group in a single setting for an extended period of time. Axiomatic to many STS ethnographies is an initial thick description of the central location in which action happens for 'the purpose of grounding the ethnography' as well as 'showing how peoples' lifeways are constrained and enabled by their environment' (Helmreich 1998:29). These locations have included the laboratory (Latour and Woolgar 1979; Lynch 1985; Traweek 1988; Knorr Cetina 1999), technology park (Helmreich 1998; English-Lueck 2003), engineering office (Henderson 1999) and workshop (Mellström 2003). Once the location is defined, action is firmly anchored in place and researchers ostensibly remain within its boundaries.

In contrast, I found visual representations of Air-Stream's interconnected wireless network in many places distributed across the city of Adelaide. Just some of my field sites included members' houses, as well as those of their family and sometimes their places of work, monthly meetings at the local school, various barbeques, member's cameras and picture phones, backyard building days, 'swap meets' and 'tech-nests', on rooftops, the website and online forum, IM [Instant messenger], IRC [Internet Relay Chat] and email. As a result, the conventional single location approach does not work for this thesis and instead I draw upon recent changes to ethnographic methods with new considerations of the field, fieldwork, point of view, position of the researcher and social and cultural contexts, all of which dictate a more flexible and fluid approach (Hess 2002; Hine 2007). Of particular relevance are what Hess (2002) calls 'the second generation' of STS ethnographies that stem from but also challenge many of the practices of older STS literature. He explains:

> Second generation examination of knowledge and technology also tend to go outside the citadel of expert knowledge to the viewpoints of lay groups, activists, social movements, the media and popular culture; to examine the contours of orthodoxy and heterodoxy in a discipline's development, including the political, institutional and economic forces that govern the selection of research fields and programs; and to examine variations in expert knowledge and technology across cultures (2002:236).

According to Hess (2002), second generational STS ethnographies are characterised by a range of field sites accessed via multiple entry and exit points. In response, the researcher moves around, following ideas, objects, metaphors and people in what Marcus (1998) has termed multi-sited ethnography. In line with the changing nature of contemporary

ethnographic study, Marcus' theory articulates a new and better purchase on the complexities of multiple field sites, ideas and things. He writes: 'In short, within a multi-sited research imaginary, tracing and describing the connections and relationships among sites previously thought incommensurate is ethnography's way of making arguments and providing its own contexts of significance' (1998:14).

Hine acknowledges that the absence of traditional boundaries makes visible new forms of anxieties and tensions about 'varying connections, tensions and identifications, and moral positions' all of which 'become harder to maintain with any certainty', yet she points out it has lead to much innovative STS work (2007:657). Heath et al's (1999) study of three heritable diseases, epidermolysis bullosa, chondrodysplasias, and Marfan Syndrome, is a prime example of a 'second generation' STS study. Researchers trace links between internet domains, documents, people and places in order to 'map relationships between on- and off-line networks of groups and individuals who produce different kinds of knowledge' with the aim of finding points of intersection in these complex technosocial networks (1999:456). Green's (1999) approach to the study of Virtual Reality (VR) also emerged from the challenges of on and offline locations, artefacts, manifestations and possibilities of this new digital technology. Unable to narrow the field, Green traces the stories, people and objects across a 'radically dispersed field of study' involving different countries, disciplines, medias, events, people and social spaces (1999:412). As noted by Lyman and Wakeford, the field is sometimes something the researcher needs to 'construct rather than discover' (1999:360).

Another innovative approach is found in de Laet and Mol's (2000) examination of the Zimbabwe bush pump 'B', which reveals multiple identities in a range of places: as a mechanical object, community device, provider of health, education and community building. Following it to different places, they reveal how it retains shape yet fluidly adapts to changing conditions. Importantly, Hine points out that 'had they set out with a defined idea of what the technology was, they would not have found out what they did' (2007:12). A key characteristic of these studies is an openness to engage with new sites as they emerge, rather than pre-determining the spatial nature of the field. Heath (2000) explains the challenges of this type of research and how a researcher needs to respond:

> Tracking genetics and genomics anthropologically during the past decade has required an agile ethnographic practice, in order to provide a map of the cultural contexts of knowledge production in this rapidly changing field of inquiry. Doing anthropology of genetics both *in vivo* and *in silico* requires a readiness to hyperlink between diverse field sites—lab, clinic, lay advocacy groups, both on-line and off-line—and between a wide array of human and nonhuman interlocutors (Heath 2000).

Although helpful in contending with multiple sites, entry and exit points, this methodological approach is less helpful in what to do when these sites overlap. This was a defining characteristic of my study of backyard technologist in suburban Australia.

Further to finding Air-Stream's field sites in many places, I found myself engaging with complex overlapping and co-located field sites in the *same* place. To explain what I mean, I include this long field note:

> *I sit at my laptop at my living room table, catching up on field notes from the meeting last night. My notebook is on my right as my camera downloads photos to my left. Simon pops up in an IM box on my screen. He provides details for me to upload photos I took at a recent installation. I open up another window on my screen and start attaching images. I'm on a slow internet connection so they take a while to load and as I continue to type notes, Simon and I chat. He attaches photos he has taken of the new node at the water tower to our IM chat. Talking about recent scavenging missions he has been on he also sends me links to the council rubbish website. As I wait for his photos to download and for mine to upload, I flick to the web address he has sent and then onto the Air-Stream website. While I'm there I read the most recent posts to the forum and see a new 360degree photos of the view from the top of the building. I see mention of another meeting so I log-in and open up my Air-Stream email to see if there is any more information. I mention it to Simon and we talk a little about it. I see his photos that have finally downloaded. I make notes about our conversation on another word document. My mobile beeps. As I reach for it I'm reminded that I'm still sunburnt from a recent installation event and I have slightly sore arm muscles from climbing up and down long ladders and winding buckets of hardware up eight concrete floors. I joke about this to Simon and he sends me a video he took of me on the day. I read the SMS text and see that is from Peter responding to an earlier question I asked about an upcoming event. I text back as I unclip the camera and take the battery out ready for recharging (Field notes 17.11.07).*

Trying to write up my field notes from experiences at one field site I found myself simultaneously caught up in multiple others that overlapped and intersected. This experience reveals the boundaries of my field sites were not firm or solid and I was never out of the field. Unlike Green (1999), for instance, I did not always have to travel to different sites in order to experience them. On many occasions they came to me, and at unexpected times.

One of the key features and challenges of ethnography about or on the internet is the nature of a constant 24 hour field site in which researchers contend with practical, conceptual and methodological challenges (Hine 2000; Rutter and Smith 2002). In line with STS of visual representations (Latour and Woolgar 1979; Latour 1990; Henderson 1999), I did not anticipate this being an issue for my study. Neither did my respondents. If anything, they expressed concern that there would be enough for me to study and wanted to ensure I had things to do *between* Air-Stream activities:

> *Ron cautiously reminds me that they [the Air-Stream group] only meet 'every now and again', that they all 'work' and 'stuff only happens now and again'. He hopes I will have 'other things to do in Adelaide in the meantime' (Field notes 28.06.06).*

Of course, there was plenty for me to do and on several occasions much more than I expected. Hess (2002) argues that recent STS ethnographies maintain a critical eye by stepping in to the point of view of the informant in their situated and then stepping out to achieve an objective view and analytic perspective. It is characterised by what he calls a 'back-and-forth movement' (2002:238). This is only possible if the researcher *can* step out of the field site. As indicated in my long field note (17.11.07), my study of backyard technologists proved to be significantly more complex and contradictory than I expected.

Also embedded in multi-sited ethnographic models is the assumption that the researcher travels from point to point without incident or accident. Little is written about what might happen *between* multi-sites.

Moving between multi-sited fields

Although recent STS researchers incorporate a multi-sited approach, attention is ostensibly focused on the movement of objects, boundaries, ideas and people, with little mention of how the researchers, themselves, physically get from site to site and what bearing, if any, this has on understanding their field sites. Heath et al (1999) meticulously map the off and online journeys of information about inheritable diseases but they do not chart their own experience of travel. Similarly, de Laet and Mol (2000) follow the water pump through multiple villages in Zimbabwe, but they themselves do not physically account for these journeys. Mobility is also a key tenet of Mol's (2002) study about atherosclerosis as it is made in multiple shifting objects, people, practices and meanings around a Dutch hospital. Hine explains:

> Moving around gives Mol a substantial new tool for theoretical intervention. Her ethnography seems to be a remarkable example of the strategy that Marcus (1995) advocated, following the object as a means to scope out an ethnographic project. Mol's insights do not happen just because she moves around. She does far more than that. But her mobility enables her to see the practices that she encounters in a distinctive light, allowing her to formulate a new theoretical intervention. Mol epitomizes the multi-sited imaginary as a knowledge form, both engaged with technoscientific experience and oriented to contemporary theoretical needs (2007:13).

Despite theoretical and conceptual mobility, there is scant mention of the moves she would have had to make to gather together these multiple meanings and field sites. Instead there is only brief reference to sitting in waiting rooms and the location of her bike left daily 'behind a fence' (2000:1). Martin's (1994) study comes closer to what I mean in that she apparently moved in and out of lay and professional medical worlds so much that her constant travels disturbed a colleague who proclaimed, "Don't you know how to stay put!?" (1994:7).

Despite what I consider to be a crucial aspect of multi-sited ethnography, movement between fields garners little or no attention. I argue that ignoring the way the researcher herself navigates distributed field sites, people and objects is an oversight in the literature. How is such mobility afforded and constituted? And how might it be made sense of by others?

Unexpectedly, bicycles played an important role in my own ethnographic experience. During my year in Adelaide, I rode a bicycle to all meetings and almost all installation sites and maintenance activities (except twice when I was offered a lift in a car because of the distance between locations). As a result, my role as a researcher became linked to my identity as a cyclist and provided an unexpected vantage point into my study of backyard technologists.

Several members viewed my interest and experience with bikes as evocative of how they thought about and made WiFi and would often use it to explain things to me. It provided a lens into a deeper understanding of DIY technology culture. These are examples of how it emerged unprovoked during interviews:

> You can go down the local store and get most of the parts. You can actually do this, just because you can. People who climbed Mt Everest, why did they do that? - Because they could. Why did you ride from north terrace right down here? - Because you could (Interview with Ron 16.01.07).

> It's a hand thing, physical memory thing, a must play with thing. (It's) sort of like, you see it and have a look at all the bits and you memorise how it all looks and feels. Just what you do when you're hacking your bikes and you're welding them. Afterwards you knock all the stuff off it and you feel it and go 'it's not very smooth'. You've got that hands-on memory thing and once you've played with it, you know what it is. You can recognise it. You tumble it over in your hands. You see it (Interview with Kerry 23.02.07).

My bike also became the means through which I was 'naturally' recruited into another backyard technology group; a local freakbike club (Fig. 6). A hand drawn note left on my handlebars, in July 2007, shortly after I moved to Adelaide, invited me to a 'Tallbike Convention', which exposed me to yet another way of imagining technology use. Like WiFi members, freakbikers' customise and adapt discarded, freely available or cheaply purchased materials, re-inscribing them with new meanings and re-imagined possibilities of use. Instead of WiFi, however, their technology is a mundane and ordinary technology – the bicycle. Over a period of eight months, I learned to make and ride bikes that pushed the boundaries of conventional cycling and the nature of the bike. I kept extensive visual and textual field notes of my experiences and gained permission to interview five members of the group. Although, this (extra) ethnographic data does not feature strongly in this thesis,

my hands-on experience scavenging materials, learning new skills with welders and grinders and tinkering in people's backyards nevertheless informs my understanding of backyard technologists in suburban Australia. As illustrated in the way Kerry assumes a shared tacit knowledge in the interview, my engagement with the freakbikers identified me as a maker, not just a consumer of technology, which afforded me entry into a particular way of expressing engagement with materials and practices. Although differently constituted, and entirely unexpected, this experience proved valuable in understanding Air-Stream. My bicycle was as much an ethnographic tool as transportation.

O'Connor's (2005) study of craft cultures offers a comparative ethnographic approach, even though she set out to join a community glass blowing studio in New York. Nevertheless, what is relevant is that her new skills offered ways to re-consider the theoretical nature of her research into craft. She writes about slowly learning to 'twirl' and 'gather' hot molten glass which 'marked progress for the novice, who, accustomed to serving the instrument, finds the instrument through techniques actually becoming a part of her' (2005:188). More recently, Laurier's (2008) study of amateur and professional video editors recognises the role of the researcher's experience in developing new skills and techniques not only in the course of participating in the field for the understanding of a practice but in relation to the broader production of sociological knowledge.

> To reflexively investigate, through the use of video-recording throughout the project, the possibilities for video editing and production as social science methodologies in their own right. To show videos can be, and are, produced as integral parts of social science projects. To open up new possibilities for digital video use for social scientists through workshops and interactive, instructional DVD materials (Laurier 2008).

Both O'Connor's (2005) and Laurier's (2008) work explore a close engagement with their field sites not only for understanding the nuances and textures of a particular culture but for learning and putting into practice new representational tools for imparting sociological knowledge.

My movements between and engagement in multi-sited fields highlighted many different ways of seeing and knowing backyard technologists and enabled me to develop along the way skills to better understand and express this new knowledge. Before I illustrate exactly how chose to represent my sociological knowledge in line with my developing field skills, I will describe how I participated in the field.

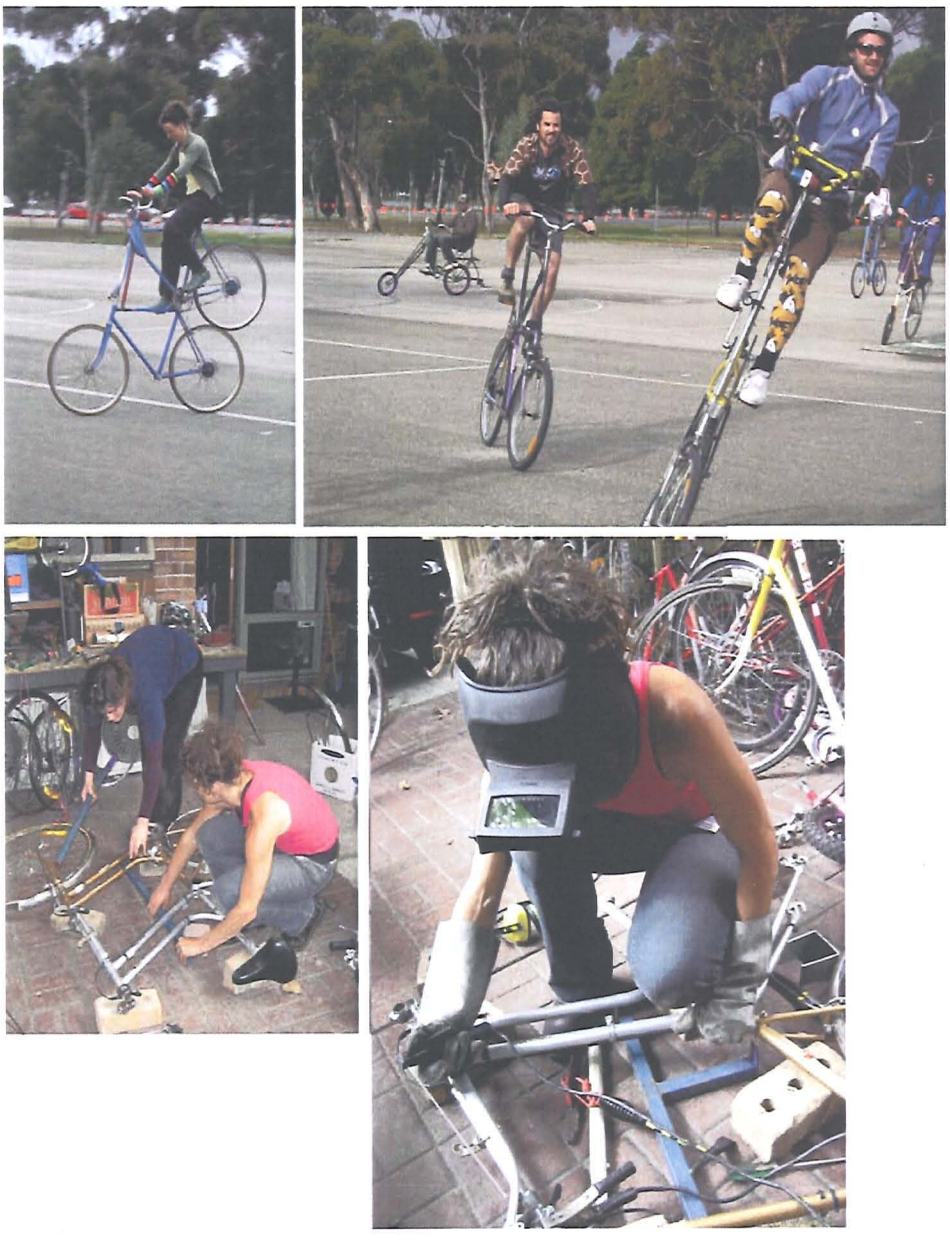


Fig. 6. Images illustrating how I learnt to build and ride 'freakbikes' in Adelaide.

Participation and observation

Irrespective of the nature and number of field sites, participation and observation are core techniques in ethnographic study. They involve engaging in everyday activities, paying detailed attention to interactions between people and objects and developing relationships with people in these settings. Emerson et al (1995) argue that participant observation is crucial for gaining an understanding of different social worlds because it 'enables the fieldworker to directly and forcibly experience for herself both the ordinary routines and conditions under which people conduct their lives, and the constraints and pressures to which such living is subject' (1995:2).

Participation was especially significant in the study of backyard technologists. Unlike scientists or engineers, Air-Stream members are volunteers. Without people who invest time to build the infrastructure, donate materials and provide access to their backyards it ceases to exist. Members learn how to make WiFi by participating in a community of practice, which involves the production of a myriad of visual representations.

In thinking about how to approach the visual culture of Air-Stream, Pink's (2001, 2003, 2004) work has been particularly helpful. She has shown that engaging and contributing to a group's visual culture provides a way to understand what it means to people and suggests finding something appropriate to the culture in focus. In the world of Spanish bullfighting, she observed the popularity of photography and adopting the role of photographer she found a four-way relationship developing 'between my informants, the technology, the images and myself as photographer' (2001:41). She explains, 'As an unaccompanied woman at bullfighting receptions and public occasions and, at the time, still learning the language an unable to engage in detailed conversation, I was grateful to have a role as 'photographer'' (2001:66). In addition to providing images for her research and access to controlled spaces, such as bullfighting receptions, she used the photographs as a way to elicit responses from respondents in home interviews. Pink's relationships with her respondents and subsequent analysis are informed by her engagement with their visual culture.

It is important to note that becoming a photographer was not something Pink (2001) planned in advance but, characteristic of Hess' (2001) definition of a second generation STS ethnography, emerged in the course of her study. She writes how it 'was shaped out of my interaction with the local people and institutions, rather than being preconceived' (Pink 2001:61). Much like contemporary STS researchers, Pink's visual approach was characterized by a flexibility to adapt to unfolding field sites. Because she did not restrict the edges of her field sites she was able to engage with and contribute to her group's visual

culture in multiple settings and gain an understanding of what it means to people in different contexts of use.

At one point I was asked to take photos at an event because several members recognised my interest and skill in documenting events. It initially worried me. How would I gain an understanding of the visual culture of WiFi if I was *the photographer?* Unlike Pink (2001) I was not 'grateful' for the role. My hesitancy came from an anxiety about undertaking a task before I had a chance to observe how Air-Stream members themselves did it. Yet, as I discuss in detail in Chapter Five, this was not a rigorously defined role. Many members also had cameras and took photos at events. Unexpectedly, in taking on the role, it afforded a way to participate in the group, which in turn provided a window into how Air-Stream members visually represented knowledge. Had I rejected the invitation out of fear of contaminating the field site I would have missed out on a critical insight into the group's visual culture. When they saw the photos I was taking and the sketches I was making I was also invited to contribute to the group's website.

Feminists have argued that the idea of objective and value free research is impossible and argue instead for the importance of differentiated viewpoints, personal experiences, multiple perspectives and connections in a plural network (Harding 1991; Harraway 1991; Coffey 1999; Skeggs 2002). Seeing from the perspective of others, hearing their voices and breaking down the barriers between the researcher and the researched are central tenets of feminist ethnography (Heyl 2002; Skeggs 2002). This means that data is not waiting to be discovered and gathered by the researcher but is a social construction, produced by the respondent and researcher and the many influencing factors that surround them. It cannot be considered 'the mechanical extraction of uncontaminated 'data' from the respondent as if one were plucking fruit from a tree' (Fielding 2003:xvii). Rather, when seen as co-constructed, knowledge becomes the result of collaborative, co-situated, co-operative activity (Whatmore 2003).

Social constructionists and feminists have long pointed out the impossibility of claims of objectivity and value free knowledge independent of social influences. Haraway argues that objectivity cannot be gained from the margins any more than it can from the centre and cautions against this uncritical assumption, proposing instead the position of situated knowledges and partial positioning:

> Politics and epistemologies of location, positioning and situating, where partiality and not universality is the condition of being heard to make rational knowledge claims. These are claims on people's lives: the view from a body always a complex, contradictory, structuring and structured body, versus the view from above, from nowhere, from simplicity (Harraway 1991:195).

Regularly reading and contributing to Air-Stream's website as well as taking photos at events and pooling them with other group members enabled me to collaboratively engage in the group's visual culture. In fact, I had a lot in common with Air-Stream members in regard to visual documentary skills and interests. Many members had their own websites and were members of online forums such as *Linux Australia*, and other OSS groups. Many also brought cameras and notebooks to meetings and other events, and were seen regularly jotting down ideas, sketching diagrams and taking photos. Laptops were also common in these events, as were video cameras. This meant there was never any concern about my documentation practices because they fitted into the group's visual culture.

One of the issues at stake here is the traditional ethnographic role of the researcher as 'acceptable incompetent' or 'novice' to the 'expert' respondent (Lofland and Lofland 1984). This strategy enables the researcher to appear open and ready to learn from those she is studying and subvert, as much as possible, the inequality of the relationship. Although this is still a primary aim of ethnography, Hess points out that the changing nature of new ICTs has given rise to the situation in STS research whereby both respondent and researcher are in similar circumstances 'groping together to understand what is going on' (2002:238). This appears to be the case provided by Heath et al (1999) who describe an experience of sharing their field notes with a respondent in order to gain feedback on their understanding of the content and meaning of a series of websites, including one made by the respondent. The respondent then asked for feedback on her own website, for guidance on what would make it more effective. Heath et al ask themselves, 'What would it mean for us to analyse her online work if our comments – still part of our study of her online work – ultimately altered her work?' (1999:455). After much deliberation they tried to remain as 'neutral' as possible in their response, conscious of the influence their interaction might have on their field of study.

The problem was not that the respondent or researchers considered themselves experts, but that the researchers viewed the ethnographic experience as an ethical dilemma. Hammersley and Atkinson (1996) take the view that having an effect on the field site and people in it does not invalidate the study but rather affords new relationships, meanings and experiences:

> We can minimise reactivity and/or monitor it. But we can also exploit it: how people respond to the presence of the researcher may be as informative as how they react to other situations. Indeed, rather than engaging in futile attempts to eliminate the effects of the researcher completely, we should set about understanding them (1996:18).

Hess (2002) calls this a further twist in STS ethnographic practice. A characteristic of multiple field sites is the porosity of boundaries between researcher and respondent. Unique to 'second generation' study is the situation in which respondents and researcher share the same kinds of methods, information sources and tools. Another interesting and related aspect emerged for me in the way Air-Stream members documented my activities in the group as I did theirs (Figs. 7, 8, 9, 10, 11). Far from it complicating my ethnographic involvement, on the contrary I found my presence on, and participation in, Air-Stream's visual culture further involved me in the group. This occurred in a number of ways such as providing catalysts for conversations at meetings and on IM about photos and photo editing software, cameras and blogging.

Fig. 7. My project described on the Air-Stream website
(Accessed 30.07.06, Available at: http://www.air-stream.org.au/Katrina).

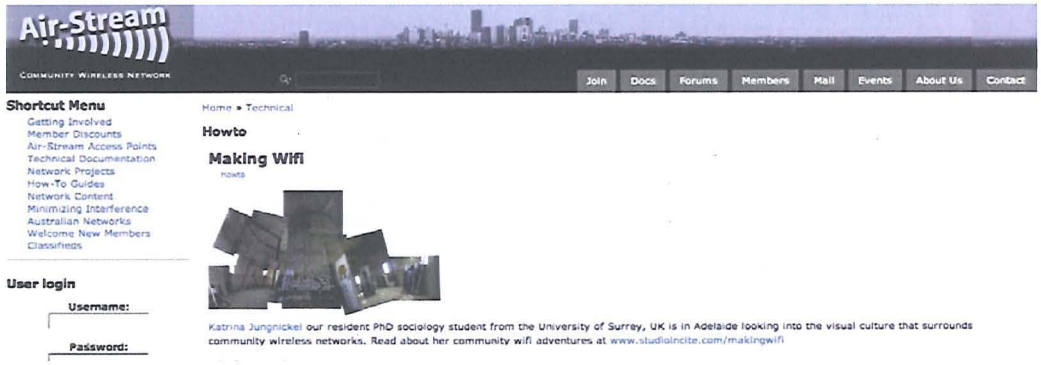


Fig. 8. My research blog described on the Air-Stream website
(Accessed 20.08.06, Available at: http://www.air-stream.org.au/makingwifi).

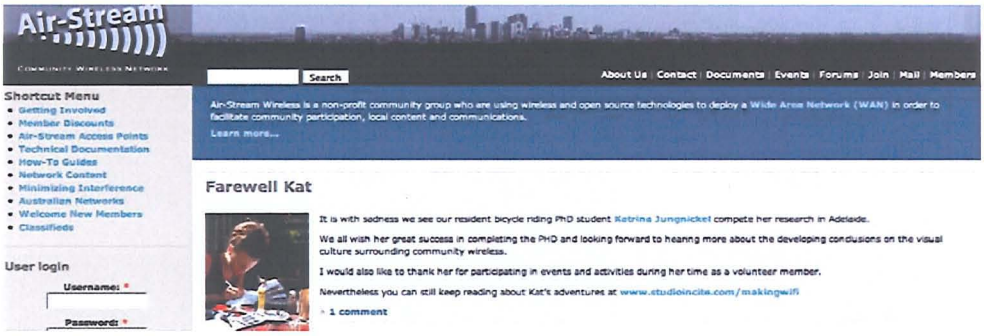


Fig. 9. My leaving the group described on the Air-Stream website
(Accessed 30.03.07, Available at: http://www.air-stream.org.au/search/node/farewell).

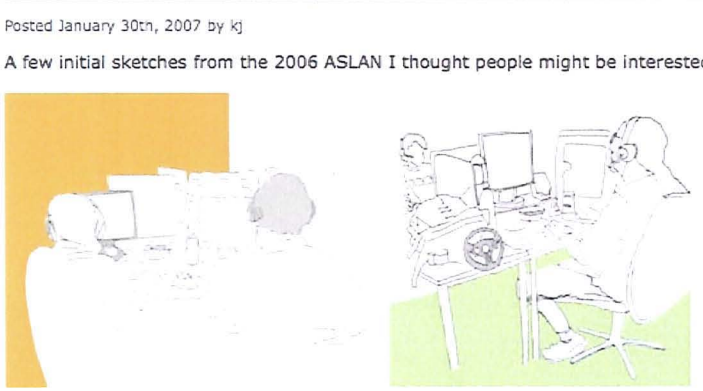


Fig. 10. Some of my ethnographic sketches I posted to the Air-Stream website
(Accessed 30.01.07, Available at: http://www.air-stream.org.au/node/915).

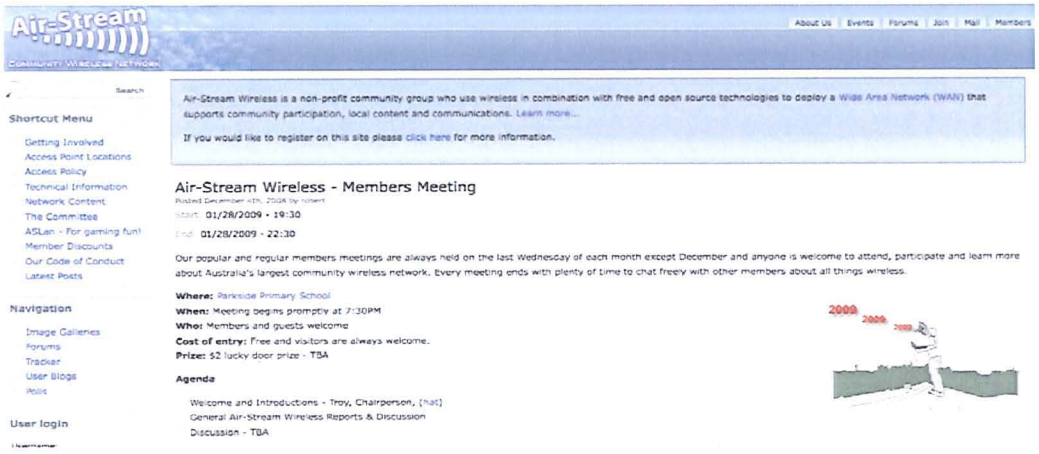


Fig. 11. I'm still connected to the group – One of my sketches in use on the Air-Stream website
(Accessed 4.12.08. Available at: http://www.air-stream.org.au/wireless_meeting).

It is interesting to note how descriptions of me by Air-Stream members on their website changed over time In Fig. 7 when I first arrived in Adelaide I was described as 'a PhD sociology student'. After a month I became 'our resident sociologist' (Fig. 8). When I left the following year I was called 'our resident bicycle riding PhD student' (Fig. 9). These shifts in familiarity indicate my deepening involvement in the group. The fact they were represented in public on their website is revealing for how members sought to incorporate me into their visual culture, as a method of enrolment and acceptance. As will become clear in later analysis, particularly in Chapters Five and Seven, Air-Stream members incorporate a diverse range of heterogeneous actors into their WiFi network, which serve to make it strong and resilient. In connecting me to their visual culture, members connect me to Air-Stream, even as I have noted, I never actually achieved a technical connection to their WiFi network. The way these descriptions attend to an increasingly familiarity also echoes how members, in familiarising themselves with potentially interruptive elements, diffuse threats posed from foreign actors. Figs. 10 and 11 show how I contributed to the Air-Stream website while in the field and how my contributions are still being used, some eighteen months after I left Adelaide. This shows how, through their visual culture, I am still connected to Air-Stream, even though I am living in another country and have no access at all to their network.

Visual and textural field notes

A significant part of ethnography that occupies much methodological literature, is keeping a record of field notes in 'regular, systematic ways' made in the field (Emerson et al 1995:1). As indicated by the earlier field note that described an experience of writing up field notes at home while simultaneously engaging in multiple other field sites, 'regular' and systematic' are not words that adequately sum up my experiences. My field experiences are better described with the words mess, collision and overlap. Yet, my written notes make it appear linear and much easier to comprehend than the lived experience. Although my ethnography was not always as busy as that exact example (See field note 17.11.07), and in fact there were points in which nothing happened at all and I wondered if my respondents had in fact forgotten about me, for the most part a distinct feature of my ethnographic experience was its intense visual and multi-dimensional nature.

Emerson, Fretz and Shaw (2002) note how 'field notes are intended to provide *descriptive* accounts of people, scenes and dialogue, as well as personal experiences and reactions' (2002:353, *emphasis* in original). Here, the term 'descriptive' confers all manner of expression, yet ethnographic literature is primarily concentrates on the *writing* up of events,

experiences, anecdotes, as well as keeping track of emotional responses and personal ideas. Although the use of visual methods is becoming more accepted in sociology there is still surprisingly little common ground between visual methods and field notes. Despite the emphasis on sight as an ethnographic tool, there is little emphasis on the visual dimension of the social world. Silverman (2001) explains why the chapter dealing with visual images is the last one in the qualitative methods book: 'Up to this point, my avoidance (or downplaying) of the visual image follows a tendency in much qualitative research (...) even ethnographers who gather observational data have sometimes been curiously reluctant to use their eyes as well as their ears' (2001:193). Similarly, Harrison asks why, if observation is a principle tool in sociological research why have we failed to supplement or complement the ability of the human eye by using available visual technologies?' (1999:77). Not only is the visual neglected as a focus of sociological study, it is also the site of deep ambivalence in sociological methods. Even visual sociology literature has been criticised for producing 'how-to manuals' which 'propose problematically prescriptive frameworks that aim to distance, objectify and generalise, and therefore detract from the very qualities and potentials that the ambiguity and expressivity of visual images offers ethnography' (Pink 2001:4). Despite the vast array of visual materials that play integral roles in everyday life, they continue to be narrowly defined in terms of what form they are recognised, which results in visual research often constrained to purely photographic accounts[23].

While these are significant, interesting and otherwise very useful texts for the researcher learning to integrate the visual into their qualitative research practice, they do less to provoke and interrupt traditional ideas of the narrow confines of sociology's understanding of the role of the visual in the construction and presentation of knowledge. The problem is less of their coverage of photographic techniques and critiques, which are most often constructive, but more of the generic inference that visual methods are photographic ones. The ubiquitous privilege of photography over other forms of visual representation leaves the impression that there is little else in the visual domain worthy of sociological interest, a consciousness that derives more accidentally than with deliberate purpose, as Banks (2001) notes:

[23] For instance, Harper's (2000) 'Reimagining Visual Methods' discusses photos of a bike ride in Italy, Collier and Collier's (1986) Visual Anthropology: Photography as a Research Method' does just that. Bank's (2001) 'Visual Methods in Social Research' deals predominantly with photographic concerns. Pink's (2001) 'Doing Visual Ethnography' focuses on photos and film, nine out of ten articles in Knowles and Sweetman's (2004) 'Picturing the Social Landscape: Visual Methods and the Sociological Imagination' consider photography.

> (...) although I set out to write a book that dealt with a range of visual materials in a relatively even-handed way, I discovered once I had finished that there was a heavy emphasis on still photography. I'm not quite sure how this happened (my own background is in film, not photography), but I'm not unhappy with it (2001:page x).

This research literature gives the impression that visual studies are either difficult or not worth the additional effort. As Denzin reminds us, 'the worlds we study are created through the texts that we write' (1997:33). Over a decade later, however, Laurier points out that, 'While it is assumed that all members of society should be able to write intelligible and well-formed texts, no such assumptions are made about assembling images' (2008:objectives). Written into his project outline is the desire to understand the use of the technology through the eyes of his respondents as well as the sociological researcher. Yet this approach is rare. Perhaps sociology's hesitancy to embrace images says more about itself than the worlds that it studies.

My own practice aligns more with what Back et al (2008) call new forms of sociological representation that resist 'flattening the texture of social experience and also the nuances of social analysis'. The entire series of workshops held under the title 'Live Sociology', in fact attend to wide range of non-conventional multi-media approaches that set out to re-think 'the future of sociological representation and ethnographic research practice' (Back et al 2008). This provides another way to articulate my methodological approach.

Two ways in which I sought to do this was through photo collages and my research weblog (or blog) started in July 2006 to document the process of making my PhD about making WiFi. The photo collages, featured throughout the thesis, derive from British artist David Hockney's 'joiners' (See Tusa, *no date*). They encompass multiple images roughly pieced together to form a much larger impression, capturing not only of the object or activity in focus but its larger socio-material and spatial ecology. I discuss later, in Chapter nine, the extent to which I feel they operate as a methodology and respond to my argument as a whole. The research blog builds on previous online research projects I have undertaken that set out to 'explore, experience and capture textual, visual and sensual narratives' (Jungnickel 2003)[24]. Called *Making WiFi: Research notes from an ethnography of community WiFi makers in Australia* (Jungnickel 2006), it draws on and contributes to literature that explores blogging as a new way of producing academic knowledge (Bruns and Jacobs 2006; Burgess 2006; Cohen 2006; Gregg 2006) (Fig. 12).

[24] See http://www.73urbanjourneys.com and http://www.studioincite.com/locatedmobility

Central to writings about academic blogging, relevant to my use in this thesis, are notions of scholastic value, social expression and participation. Bruns and Jacobs write: 'Re-placing somewhat outdated email lists and personal websites as vehicles for exchanging ideas and information, blogs represent for authors an opportunity to reach out and connect with an audience never before accessible to them, while maintaining control over their personal expressive spaces' (2006:5). Blogs are typically structured in hierarchical calendar format, and exist in single dimensional digital form, which may at first appear counter intuitive with my desire to un-flatten my ethnographic field notes. Yet hyperlinks, tagging and multi-media characteristics of blogs offer ways to explore and cross connect multi-dimensional ideas. For instance, my research blog enabled me to combine field notes with images, sketches, links to relevant media articles, other people's blogs and interact with people around key ideas. It was also viewed by a diverse audience, which meant comments to my posts came from fellow students, Air-Stream members, freakbikers, family and other 'familiar strangers' (Paulos and Goodman 2004). It is important to note that I did not publish all my field notes on my blog, nor was the blog my only documentation tool. Instead I considered it one of many ethnographic tools at my disposal.

Because Air-Stream members were used to communicating with each other through images, text, maps and diagrams, my blog provided another channel through which I participated in Air-Stream's shared visual culture. It was, as Pink (2001) suggests, an approach appropriate to the culture in focus. Although only a few members commented directly on my blog, I knew many members were aware of it because, as indicated in Fig. 8, a description and link was posted on Air-Stream's website and it also regularly sparked conversations.

Fig. 12. A screengrab from my research blog
(Accessed 30.07.06. Available at: www.studioincite.com/MakingWiFi)

This is an example of one such incident at an Air-Stream meeting:

> *Jim tells me he liked my blog post about backyard infrastructures – I compared Hills Hoist clothes lines and WiFi antennas. I only wrote it this afternoon so I am surprised he has already read it. He tells me funny stories about swinging on the clothesline as a kid and getting in trouble when he broke bits of it (Field notes 31.08.06).*

There was another occasion when I received a comment on my blog from someone I did not know, offering me insights into the commercial side of WiFi in Adelaide. Shortly afterwards, I received emails from two different Air-Stream members explaining who the commenter was – a local disgruntled ISP owner renowned for posting hostile comments on Air-Stream's website. This incidence revealed to me another field site – community relationships with local ISPs mediated in various forms. It also served as a reminder of the very public nature of this particular tool in my ethnographic toolkit.

On another occasion I drew on Air-Stream members' practice of sharing photos and proclivity for barbeques to catalyse debate around emerging ideas in my thesis. Copying the nature of community wireless meetings and installation events, I held a barbeque in the yard of a house I was living in during my fieldwork. I devised a homemade exhibition for the purpose of making visible my production of sociological knowledge and involve my respondents in my analysis. Rendering knowledge visible in this spatial form draws on the work of researchers such as Hjorth (2005, 2007) who venture into their work in the process of making and representing it. Set up in the space between the side of a suburban Adelaide house and a neighbouring fence, I displayed photos I had taken along with printed blog posts and extra writing using clothes pegs, lengths of electricity and USB cables. At the end of the barbeque, respondents took fragments that interested them home. I discuss in more detail and provide images of this approach in Chapter Nine.

Messiness and the potential for new expression

Confronted with multiple overlapping field sites and being documented myself as I documented others was at times daunting. Axiomatic to ethnographic literature is the expectation of becoming 'overwhelmed', 'unnerved' and 'daunted' in the field (Fetterman 1998; Coffey 1999; Atkinson et al 2002, Fielding 2003; Law 2004). Although an essential part of getting immersed in a new field, the researcher is expected to take control, and organize this messiness into a linear sociological argument.

Mess in certain circumstances, however, can be seen as productive, imaginative, exciting and generative of new ideas with many writers deliberately attending to the disruption of the

notion of the field as static and the respondent as passive in contrast to the active researcher (Haraway 1991; Massey 1994; Rose 2003; Whatmore 2003; Law 2004). Mess can take many shapes and forms, experiences and conditions. For instance, Whatmore (2003) sets out to 'unsettle and trip' traditional ideas of fieldwork as an *investigation of the world* which positions the researcher at one remove from the world and renders 'it' a passive object of study' (2003:90, *emphasis* in original). This feminist line of argument holds the notion of intimate and emotional research, of collaboration and disruption in contrast to disembodied, impartial and contained objectivity.

Mess is also made explicit in Law's (2004) examination of sociological methods. He argues that researchers are traditionally trained to extract neat linear arguments from messy and complex worlds but that this approach contradicts our own understanding of the world and in turn limits the possibilities of other forms of knowing.

> If the world is complex and messy, then at least some of the time we're going to have to give up on simplicities. But one thing is for sure: if we want to think about messes of reality at all then we're going to have to teach ourselves to think, to practice, to relate, and to know in new ways. We will need to teach ourselves to know some of the realities of the world using methods unusual to or unknown in social science (Law 2004:2)

Law defines mess as textures, ideas, objects, artefacts, places, people and emotions that are difficult to deal with within the traditional confines of social science; an indefinable array of complexities that are conventionally ordered and organised in the pursuit of sociological knowledge. He argues that current 'academic methods of inquiry don't really catch these' messy aspects of life (2004:6). Instead, he calls for alternative ways of *catching* non-linear and messy worlds that extend social science knowledge beyond traditional neat and ordered boundaries. What this means for ethnography involves accepting the presence of multiple unfolding field sites, shifting definitions of technology and meanings that surround them.

Because ethnography is often described as a lived craft rather than a structured practice much is made of the researcher herself as the instrument of research (Atkinson, 1990; Burgess, 1994; Fielding, 2001; Pink, 2001; Lofland and Lofland, 2002). This requires a researcher to acknowledge the influence of her personal interests, bias and knowledge of the area of enquiry in relation to her observations and interpretations and to devise a way to express them appropriately. Fielding notes, 'our knowledge is always situated – in our biography, our circumstances, our allegiances and interests' (2003:xii).

However, there are contrasting views as to what this might mean. For instance much ethnographic literature describes the hard, stressful and emotionally challenging work of

field research and although reference is made to the pressure this might have on the researcher, it is largely addresses as something that needs to be 'managed' (Coffey 1999). Coffey points out that 'this sort of approach does not address, in any detail how fieldwork shapes and constructs identities, intimate relations, and emotional self and physical self' (1999:5). She suggests the emotional, physical and mental demand of long term immersion encountered by the researcher should become something not to filter out but rather to be embraced as 'epistemologically productive' (1999:78). In terms of what Mills (1964) calls the craft of sociology, these messier and complex encounters influence the 'life experience' and intellectual skills of researcher and indubitably infuse the research, potentially for the better. 'In this sense craftsmanship is the centre of yourself and you are personally involved in every intellectual product upon which you may work. To say you 'have experience, means, for one thing, that your past plays into and affects your present, and that it defines your capacity for future experience' (Mills 1959:196).

Building on this literature and the messiness of the many field sites I encountered during my study of backyard technologists in suburban Australia, the way I used my blog, Air-Stream's website and my ad-hoc installation provide means to explore my involvement in other kinds of representations of sociology knowledge.

Conclusion

This chapter has outlined the challenges of undertaking a 'second generation' STS study (Hess 2002). Specifically, I have described how multi-dimensional and multi-sites objects of enquiry of WiFi are not neat, distinct or easy to capture answers in a singular form. Instead many fields of study constantly unfolded in multi-dimensional and temporal forms and appeared messy. To accommodate these shifts and gain a sense of what was happening, I too had to reshape my ethnographic engagement and follow field sites as they appeared, tracing their movements as they overlapped and tangled and taking opportunities offered to participate in the group(s) even when they initially appeared counter-intuitive. This chapter established a way of approaching a study of the visual culture of backyard technologists engaged in the making of WiFi, not only through participation but also by contribution, which in turn influenced the production of sociological knowledge. The following chapters look in more detail at how members make WiFi.

Chapter Four.

Disorderly design

In this chapter I identify and describe the nature and role of representations at an Air-Stream monthly meeting. I explain how they connect people together, aid recruitment and teach members about new applications, yet they do not conform to the singular, layered, sequential and hierarchical or highly ordered characteristics of inscriptions found in science and engineering contexts in STS. Instead, I draw attention to the multi-dimensional, co-located and sometimes contradictory character of representations made by Air-Stream members. I argue that Air-Stream's scattergun and seemingly messy culture may prove to be more resilient and responsive, ideally suited to the idiosyncrasies of WiFi, the people who make it and their disparate locations. I also introduce and explain the role of the 'barbie' in the making of WiFi, arguing that it too is enrolled in the group as a means of contending with the complexities of the technology. Overall, this chapter unsettles the precise and orderly role of inscriptions as established in STS literature by revealing the disorderly design of Air-Stream's representational culture.

In the quadrangle, at a 'barbie'

> *A man stands in the middle of a tarred quadrangle in front of a steel rectangular 'barbie' [barbeque] blackened by use and packed with neat rows of thin non-descript pink 'snags' [sausages]. With a pair of tongs he makes a small gap on the hot plate and shakes out a tangle of onion slices from a plastic container that jump and sizzle in the hot oil. Nearby, on two school tables carried out of a nearby classroom especially for the event, lie three bags of white sliced bread, a plastic bottle of tomato sauce, paper serviettes and plastic plates. Rolling back on his thongs [flip flops] the man tries to dodge the spitting fat. He also fans an edge of his loose cotton shirt in an attempt to cool himself. Summer in Adelaide is fierce and even at seven o'clock at night, a thick residual heat baked into the black tarmac underfoot rises up around our legs. (Field notes 29.11.06)*

Barbeques (or 'barbies') are occasionally held before monthly Air-Stream members meetings in the central quadrangle of a Public Primary School on the fringe of the city parklands. Access to several of the single storey stone buildings that edge the quadrangle, the staff kitchen, toilet block and carpark has been negotiated by an 'old member' of the group who also happened to be the school's IT consultant. Despite no longer being involved, the agreement still stands and it is one of only a few constants. The barbeque, for example, is not held every month but only in summer, provided the weather is 'not too hot' and when volunteers offer to pick up food and get to the school early to prepare. If a barbeque is on, the time changes as well. The meeting might be scheduled for a 7.30pm start, but the barbeque requires people to people arrive 'early'. In addition to the time, the chef and the type of 'snags' on offer, the location of the barbeque in the quadrangle is subject to change. Sometimes the sun-shaded area in the centre of the quadrangle or the wind-protected edge of

the main hall is used. Sometimes food is not eaten until after the meeting and in these circumstances the barbeque is located nearest the school office, which is equipped with an outdoor light. Numbers of attendees are also never fully known. Sometimes barbeques attract up to fifty people while fifteen to twenty five will attend a non-barbeque meeting. Similarly, the meeting itself is held in a variety of rooms; in the small computer room building, the larger hall or, with minor shuffling of chairs and book shelves, the library. For over five years, members have been making familiar use of different spaces and equipment within the school perimeter, yet at the end of the night everything is packed up and rearranged (Fig. 13). Much like the invisibility of WiFi radio waves that pass through the air around the school, there is little visible evidence of Air-Stream's presence. So how do people know when and where these meetings are? How do they know if it is a barbeque meeting or just a meeting? In fact, how do people know about the group at all? And what do barbeques have to do with WiFi?

Connecting people together

> *I start to introduce myself to the cook. I've attended meetings for six months now and I haven't seen him before. But he interrupts me saying he knows who I am and has read about me on the website. He tells me he is Jason, one of the 'original members' who at the age of 18 set up the network in 2001 with Tim and 'a few mates' but he has not been very active in the group recently due to a new job in his dad's winery coupled with a house move, which meant he had to take his antenna 'down'. He has contacted his new landlord and hopes to reinstall it on the roof of a communal block of flats but he's done a few 'site surveys' and it 'doesn't look good' (Field notes 29.11.06).*

Jason is currently disconnected from the network. Disruption in the form of a new flat and a new job, as opposed to technical problems, initially brought his antenna 'down'. Then a 'site survey', which generates information about the strength and direction of nearby wireless signals that assist in getting an antenna 'up', has been disappointing at the new location. Even if an antenna works in one location, it may not work well, if at all, in another. Yet, despite this setback, Jason does not seem anxious, nor is he detached from the group. He clearly knows what is going on; after all he is at the meeting, volunteering as the chef and knows about new members. This is because, as he explained, he read the Air-Stream website. It is both published on the WiFi network for those who are connected and made publicly available on the internet for those who are not. Like me, Jason found out about the barbeque via the agenda Ron routinely posts on the website a few days in advance of every meeting (Fig. 14). Jason may not be part of the network, but he is still part of the group.

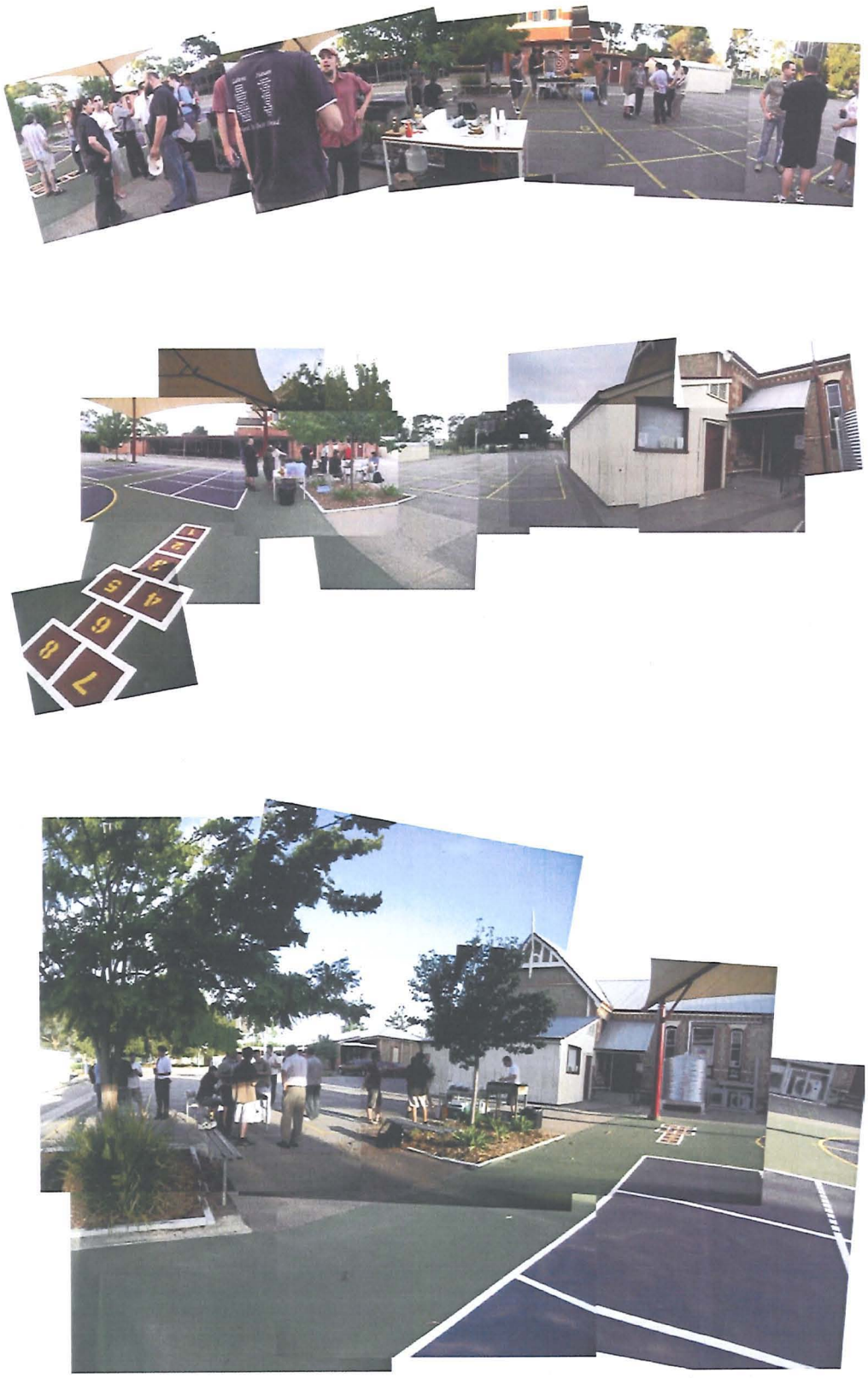


Fig. 13. Photos of various 'barbies' held in the quadrangle of the primary school 2006-2007.

Members Meeting - Tonight - Wednesday 31st January 2007

Submitted by robert on Sat, 2006-12-02 19:31. Events

Tonight is our next regular Air-Stream Meeting and all members are encouraged to attend to contribute to the development and improvement of the association.

Where: Parkside Primary School.
When: 31/01/2007, 7:30PM
Who: Anyone who has a genuine interest in community wireless networks.

Agenda 2007

- BBQ, gold coin donation, come early
- Planning for 2007 - What do you want to see happen this year? have your say..
- Network Update
- Equipment for the Apana upgrade and other new sites on display
- General Discussion

» login or register to post comments

Fig. 14. Agenda for a monthly barbeque meeting posted on the group's website (Accessed 31.01.07, Available at: http://www.air-stream.org.au/meeting31012007).

> *Jason and I are drawn into conversation about London WiFi groups with Kerry, Jane, Jen and Kevin who stand in a semi-circle around the barbeque. Stretching his arms out in front of him and bending one leg behind, Kerry explains how he used to 'rig up' networks across the small alleyways in Southwark and he looks at me, saying 'you know where that is?' I do, and I nod. He leans forward to physically explain the precarious nature and comedic potential of being a large man hanging out of a small window at a great height. Everyone laughs (Field notes 29.11.06).*

Although he has been involved in the group for six years, Jason's story is surprisingly similar to that of Kerry and Jane who are not connected to the network either. The difference lies in the fact that they are *unconnected*, having never been connected at all. Despite trying for the past year, they cannot access any of the local Air-Stream antennas from the roof of their rented house in the south of the city, due to trees and buildings that block the signal. This however has not stopped Kerry from joining Air-Stream as an 'official' member, the name for someone who has paid the annual AUS$50 [GBP£23] fee. He regularly posts pictures and stories to the website of attempts to get connected and is often called upon to 'demo' [demonstrate] complex technical ideas, which draws upon his work as an IT manager at the local university as well as his community wireless group experience in London. At thirty three years of age Kerry is a big man with a long beard, often wears black t-shirts and jeans and says most people think he is 'scary looking', yet, he is often the first to volunteer and share his experience and knowledge. At the 2007 AGM, his activity was recognised and he was voted onto the committee.

Jane, on the other hand, is a self-confessed 'tourist', which is what she calls people who attend meetings without officially joining. She is forty-three and works as a freelance graphic designer and volunteer for local OSS events. She regularly promotes the group's activities on her personal website and in what she calls 'Jane rants' on OSS listserves and

noticeboards. Even though Jane and Kerry have never been connected to the network, it has not stopped them from being involved in the group or from inviting others to meetings.

> *Jane and Kerry have brought Kevin, a friend and colleague from their OSS activities, to the barbeque. Jane calls Kevin a 'newbie' and he smiles when she does this because they both know even at twenty-one years of age and new to Air-Stream, he is not new to IT or volunteering. He has been working for IT charities and related organisations during high school and more so now he is finished. He says he is interested in WiFi and in joining the group, even though he knows he 'lives on the wrong side of the hills' and 'off the map' but still hopes to 'find a way' (Field notes 29.11.06).*

The Hills, so called by locals, often pose obstacles in the network because they are in fact mountainous national parklands, Mount Barker and Mount Lofty, filled with tall eucalyptus gum trees. Guided by the group's network node map that represents the coverage of the network across the city, Kevin is aware it is unlikely that he can connect to the network from where he lives. However, this has not stopped him attending the meeting. His 'hope' to 'find a way' suggests he will meet experienced people who will help him get connected.

Jen at nearly fifty years old and a fulltime IT technician at a large commercial telecommunications organisation is one of the most experienced people at the barbeque. She is the owner of a seven-metre steel tower embedded in two square metres of concrete located next to an in-ground pool in the sprawling backyard of a house she owns and shares with her teenage daughter in a suburb west of the city. Jen has been a ham radio hobbyist since she was twelve years old and an Air-Stream 'committee member' for more than two years. As a result her tower holds a variety of radio and WiFi equipment. She is one of the most established 'official' members with a sophisticated 'setup', a term used by members to describe the technical assemblage of an antenna, even though she occasionally has to climb up and 'jimmy' [adjust] her antenna to get a better signal.

These brief introductions reveal how membership in, and connection to, the Air-Stream network is far from straightforward. There is no one single type of 'member' or linear process of becoming involved in the group. The pre-meeting barbeque reveals the presence of 'old members', 'original members', 'official members', 'committee members', 'tourists' and 'newbies'. In fact, the absence of 'non-members' suggests no one is ever excluded from the group and the continued presence of the 'old member' illustrates the absence of a clear exit point as well. There is also no linear trajectory to follow. People can be several types of members at the same time. Jason for instance is an 'official' and an 'original' member and for a while he was a 'committee' member as well. For Air-Stream, membership is not a singular concept.

Further complexity emerges in terms of who is 'unconnected', temporarily 'disconnected', 'trying' to get connected or just considering it. As Jason and Jen illustrate, even those with sophisticated knowledge and experience become disconnected from the network from time to time. Conversely, Kerry and Jane have never been connected and yet they are actively involved in the group and Kevin, who currently has little chance of connecting, is still at the meeting and furthermore, expresses interested in joining as an 'official member'. Connection is clearly not a neat or definite achievement at the end of a straightforward process. Instead it appears variable over time and subject to conditions. Although a primary aim of the group and the central promise of WiFi ('always on') technology, is connectivity, like membership in the group, is not singular, guaranteed or it seems even expected.

Fieldwork at the Air-Stream barbeque reveals two clear points. Firstly, connecting to the network is not easy. It is not simply a case of buying a WiFi device and plugging it in. Instead, it appears to involve a significant amount of investment in terms of time, work and interest. This marks a departure from conventional commercial WiFi models. Secondly, being a member of Air-Stream volunteer community wireless group does not predicate being connected to the network. Just as the internet is disaggregated from WiFi, now we see how membership to the group is disaggregated from the network. The significance of this point is sharpened if compared to another group. Take for instance an iceskating club. Imagine joining even if you had no iceskates or could not get to the rink. Or, further still, if you had both but occasionally the rink disappeared and you could not access it. This example goes some way to illustrate what is going on here. Although there is a desire to connect to the network, it is not a requirement of being in the group because as illustrated by Jason and Jen, even achieving a connection to the network does not guarantee staying connected to the network. Why then, do people meet? If they are not uniformly connected to the technology, what connects them?

What connects all of these people and brings them together is a collective engagement with a range of representations of the network. A shared way of seeing and representing the world is the group's visual culture (Alpers 1984). In this section I have shown how Air-Stream's maps, photos, diagrams and website all serve to connect people together irrespective of their actual connection to, or membership in, the network and they do so in ways not wholly anticipated given STS literature regarding the role of representations (Latour and Woolgar 1979; Latour 1990; Henderson 1999). Uniform to these studies is a clear description of place, key actors, actions, devices, materials, time and set rules that together constitute the route novices must follow to attain membership to a specific culture.

In contrast, Air-Stream's visual culture does not enforce a typical or universal perspective, demand obedience to a particular style of engagement or alienate those who do not fit a narrow description. It is open and available to anyone, inside or outside the group, connected or unconnected from the network. It does not assume everyone is connected nor does it insist upon it. Furthermore, it does not impose a systematic or uniform progression through the group. As a result, there are none of the conventional restrictions in place that determine who can and cannot gain access. Instead, it accommodates the group's diversity and shifting types of connection and membership. Importantly, what this means is that although WiFi is technically designed to connect people together, it is Air-Stream's representational culture that actually accomplishes it.

Transactions and interactions

Barbeque meetings represent a critically important place where Air-Stream's visual culture is found. In addition to socialising and eating, barbeques are also places where goods and services are transacted. At this barbeque at the end of November, this was clearly happening.

As the heat drops the numbers continue to swell and apart from Jane, Jen and I, the rest of the group who arrive are men, in two age brackets; eighteen to twenty five and forty to fifty. A few are dressed in dark trousers and blue open necked collared shirts, while others wear shorts or jeans, round neck t-shirts and trainers, with backpacks or computer satchels over one shoulder. Soon there are about thirty people in groups of four and five clustering in the quadrangle.

> *One cluster of young men surrounds John, who balances his open laptop with one hand and points to images on the screen with the other. He is selling wireless equipment, taking orders at the meeting, and on the website, to make bulk purchases from suppliers in Asia and distributing equipment weeks later at meetings at cost price. (Field notes 29.11.06)*

Using photos, John successfully holds the attention of his audience and sells his product (Fig. 15). The images work to represent these objects so he did not have to bring the bulky antennas or boxes to the meeting in order to prove they exist. The fact these images did not change from when they were taken to their display at the barbeque give his buyers confidence they represent exactly what it is that he is selling. According to these mobile and immutable characteristics, John's images can be considered 'inscriptions' (Latour and Woolgar 1979). Without these images, John would no doubt have had to work much harder to attract the attention of buyers and achieve sales. He might have, as Latour (1990:22) observed of scientists without their visual aids, 'stuttered, hesitated, and talked nonsense,

and displayed every kind of political or cultural bias', or at the very least lacked a certain kind of credibility with his audience. For both John and Latour's scientists, inscriptions served to 'keep them in their proper place' (ibid).

John's visual activities clearly share much with Latour's (1990) insights regarding the role of visual representations in science. However, there are other activities taking place at the barbeque that appear contradictory. Another member of Air-Stream is also selling objects - this time they coalesce around logos and symbols of membership.

> *Another cluster of men surround Peter who sits at a school desk to the left of the barbeque that is covered in neatly arranged rows of black collared shirts, beanies [woollen hats], and tinnie-holders [beer coolers], all of which are embroidered in blue with the words Air-Stream and a symbol of radio waves. Peter explains to the group of four men standing in front of him that he is selling 'Air-Stream merch'. Pointing to each item he says the shirts are 'twenty', the beanies are a 'tenner' and 'tinnie-holders are on a meeting special' which includes a can of soft drink for a 'fiver'. Peter is wearing an Air-Stream black shirt that has a different design to the ones he is selling. On his, the Air-Stream logo is white and another logo sits above it. He lives in the north of the city and is part of, what he and five other local members call, The Northern Wireless Order or NWO for short. They designed the extra logo together and Simon used his mum's sewing machine to stitch it onto their shirts. (Field notes 29.11.06)*

Peter's articles of merchandise are both mobile *and* mutable (Figs. 16, 17). Like John's photos, this merchandise does not degenerate and can be widely distributed. Yet, there are several versions of Air-Stream's logo. The fact that Peter is wearing one version of the logo and selling another points to an absence of tension or anxiety around such lack of consistency. Here, different versions of the same logo keep members not in one 'place', like Latour's (1990) scientific inscriptions, but in several *places*. There are multiple versions of the same representation, some of which appear contradictory. The different logos could be viewed as a division in the network, a splintering of a whole wireless network into location based portions. Yet this does not happen. They co-exist. This draws striking contrast with the orderly role of visual representations in STS in engineering and science. Latour (1990) describes how power is achieved when singular inscriptions are layered in increasing 'cascades', a process by which information is assembled in a hierarchical system. Similarly, Henderson describes how engineering sketches are 'built up through a cascade of representations and rerepresentations to construct a final design' (1999:74). What emerges at the barbeque is more in keeping with what de Laet and Mol call a technology that 'doesn't impose itself but tries to serve' (2000:226).

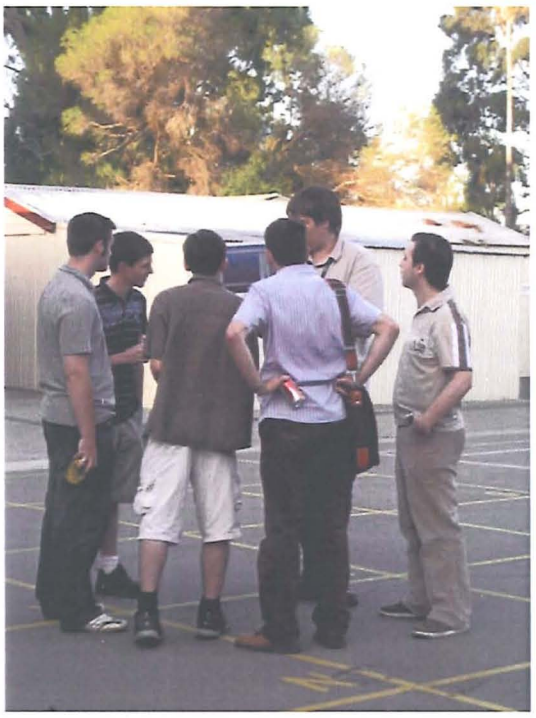


Fig. 15. John shows photos of equipment for sale.

Fig. 16. Close up of the NWO logo above the Air-Stream logo

Fig. 17. The merchandise table at the 'barbie'.

Air-Stream's representational culture is pivotal to transactions and interactions, but not in ways wholly anticipated by STS literature. It does not subscribe to a linear model of cascading layers. The fact that Peter does not even ask if his customers are members or connected to the network means anyone can buy and wear Air-Stream merchandise. Kerry, for example, regularly wears his Air-Stream shirt even though, as mentioned, he is not and has never been connected to the network. Thus, rather than providing proof of membership or connection, which would no doubt divide the group, Air-Stream's merchandise serves to visually strengthen connections between people who want to be involved rather than imposing rules and regulations on people and separating those who can from those who cannot.

Recruiting people

Air-Stream barbeques put the network on display and, as a result, complicated aspects of participation are constantly produced and reproduced. Because the agenda on the website invites 'anyone who has a genuine interest in community wireless networks' to the meeting, there are always new faces (see Fig. 14). New faces, however as we have seen with Jason, are not always new people and while some 'newbies' like Kevin, attend meetings with members, others arrive on their own. None, however, arrive without some knowledge of the network.

> *Three men in their early twenties with short-cropped hair, in blue jeans, coloured t-shirts and scuffed trainers with satchels slung over their shoulders wander across the quadrangle to the barbeque. One of them introduces himself as Joel and he tells Kerry, Kevin, Jen, Jane and I that he found out about the meeting on the website but he has been interested in WiFi for a long time. He says he came along to the last Air-Stream Open Day. He says he wants to join so he and his friends can play games but he is not yet connected because of 'time, trees and apathy'. Kerry nods in agreement and asks where he lives. He says 'Pasadena'. Kerry says he will have no trouble getting connected there. Joel says he knows because he has seen the map. Kerry points out a young man in the crowd as 'Ben', who is 'the node' at Pasadena that Joel 'should talk to'. Joel asks if Ben is 'Albatross' [Ben's online name] and when Kerry nods, he says he has already been in contact with him on the website forum (Field notes 29.11.06).*

Joel's story reveals multiple entry points into the group enabled by a range of publicly available visual representations of the network. Long before he will get connected, Joel has accessed important knowledge about Air-Stream. He has a copy of the map, accessed the website, participated on the forum, attended an Open Day and now a meeting. Just as there is no clearly identifiable exit, or progression through the group, there is no single or defined entry into the group; there are many. Here, what is interesting is not only the breadth of representations available to people outside the group, but also the lack of a sequential order

in which to encounter, understand and put them together. Air-Stream's visual representational practices stand in sharp contrast to those documented by Latour (1990) and others who talk about layered systems of knowledge with increasing degrees of mastery, thus increasing restrictions to entry and participation.

Latour and Woolgar describe the inside of the science laboratory as 'a factory where facts are produced on an assembly line' (1979:236). Latour (1999) has identified a similar rigorous sequential system outside the lab. Although he hoped to experience a site completely foreign to the lab when he joined a field trip to the Amazon jungle, he instead witnessed something far more ordered. Observing a numbered tag nailed to a tree branch he writes, 'I thought I was deep in the forest, but the implication of this sign, "234", is that we are *in the laboratory,* albeit a minimalist one, traced by the grid of coordinates' (1999:32 emphasis in original). This system of annotation transformed the messiness of the jungle into an ordered space in three key ways. Firstly, the production of texts, graphs and images were fixed to raw materials in a way that enabled them to be noted, categorised and transported. Secondly, using text based materials scientists could compare and contrast differing specimens on a flattened and contemporaneous plane. Finally, these practices resulted in information that was sequential and hierarchical in structure, with each one building upon the one before. Latour calls this process a 'chain of transformation' or 'circulating reference' (1999:70). The key characteristics of this model are the long length of chains and the systematic transformation that occurs at each point. While each point is reversible, the process is ostensibly one-way and sequential and a link is maintained to the original material. This model is distinctly not what characterises Air-Stream.

Joel's experience suggests that each representation of the network that he encountered was designed to operate independently, as well as in relation, to one another. These forms of knowledge do not appear sequential or linear. Although Air-Stream's representations are co-located and occasionally contradictory, they appear to work together, even though they may not fit together in neat chains or cascades. Tim's concept of 'visual attachment' helps to explain how this works:

> I guess because what we do is so technical, without some tangible thing for people to visually attach it to it's hard to think about it in your head, especially if it's something that is completely foreign to them. A lot of people who come along, new people in particular, who are wondering what this is all about, when we explain it to them, which we do on a lot of occasions, it is so much easier if you've got something there to show them - diagrams and maps and things. It just makes things a lot easier. Particularly with a map, people can go, 'Oh look I'm there and I can see that'. It pulls them in as well (Interview with Tim 08.03.07).

Aware that Air-Stream is 'foreign' to many 'newbies', Tim's comments suggest that representations play a crucial role, not only in communicating and translating the technology but also in aiding recruitment or, as it is known in science, 'enrolling allies' (Latour 1990). However, the way that it does this is not in layers of hierarchical entities but rather in terms of multiple and overlapping combinations. In line with this it is possible to view Joel's seemingly random assembly of visual representations not as an accident but the result of the group's disorderly design. Thus, what may at first seem chaotic and unplanned has in fact a calculated purpose. It has been specifically designed to appeal to the heterogeneous audience located outside and inside the group.

Mol's (2002) use of multiplicity provides another lens in this interpretive frame. So long as representations are distributed in different places, it does not matter if they 'cannot be smoothly drawn together into a single object' (2002:88). Yet, Mol's notion of multiplicity does not explain how different and contradictory representations make sense in the same place. And this is not by accident. Tim knows that the more representations available to people like Joel, the stronger the attraction and increased possibility they will visually attach to the network and the group. In view of this, Air-Stream's seemingly scattergun approach works to attract people in ways that a single, narrow and linear version would not.

The barbeque and WiFi?

> *Jason doesn't need to call people over for food because the smell of meat beginning to burn loosens the clusters distributed around the quadrangle only to reform around the barbeque. Hands reach into pockets and coins drop into an old Milo tin [Malt milk drink] wrapped in a hand-written label that reads 'Hi! I'm Mr Cantenna. Please fill me with gold coins to help support Air-Stream'. Then, curling a piece of sliced bread in one palm, they squirt a line of sauce in the centre and wait, one by one, for Jason to deposit a partially charred 'snag' [sausage] and some onions on top. People then wander slowly away, eating and talking. A few minutes later Ron yells from the door of one of the school buildings that we have to start now and are already late because the barbeque has been so good (Field notes 29.11.06).*

Air-Stream barbeques are not really about food. Approximately ten minutes in one and a half hours before a meeting or a few minutes after a meeting are dedicated to actually eating (Fig. 18). What then has a barbeque got to do with WiFi? To explain this relationship it is essential to understand a little of the cultural significance of the 'barbie' in Australian culture, and I turn to Thomson (1999) who has written extensively on this subject.

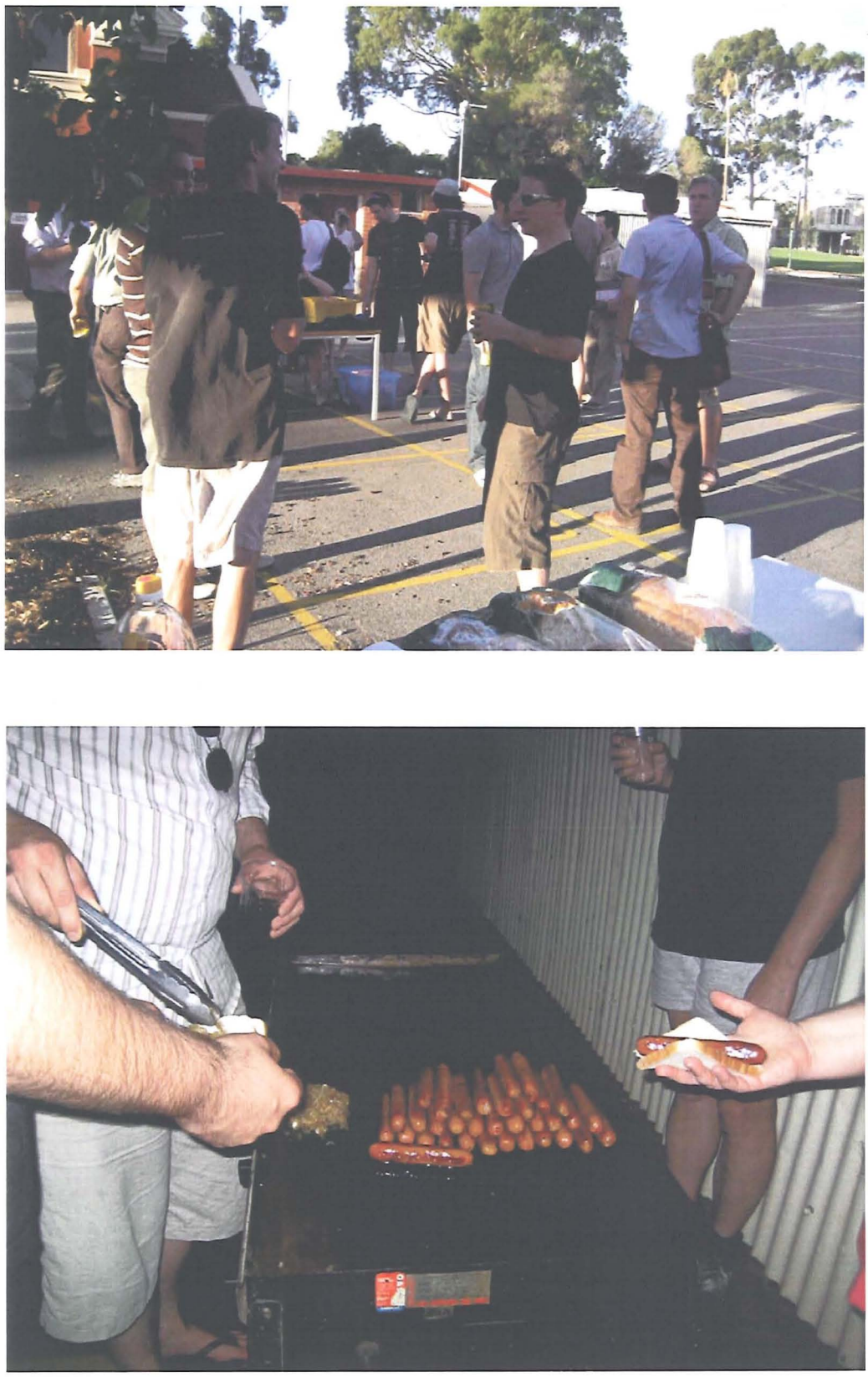


Fig. 18. The 'social framework' of Air-Stream's 'barbies' (29.11.06).

> An Australian barbeque is an instant excuse for socialising. The barbie is a loose social framework in which many things are possible – an open door for anything from fairly outrageous drunken behaviour to the simple pleasure of eating outdoors in the company of friends. The barbeque has become the quintessential Australian social event. This appears to confuse people from overseas, who are expecting some sort of culinary display. They don't realise that a barbeque is more a form of behaviour (in some cases fairly pathological at that) or ritual rather than the cooking of gourmet food outdoors under strict foodie guidelines. It's too bad if it got rained out or you ran out of gas or there was a terrible family fight. You were going to have a barbeque, and that's the main thing (1999:112).

Thomson (1999) argues that the barbeque is much more than a burnt 'snag', a cooking tool or an outdoor appliance. In fact, it does not even matter if the food is awful. Its purpose is much larger. The barbeque is a ritual that is so rigorously embedded in the national cultural framework that its original purpose, the very thing it is designed to do (in this case, cooking food) is only one of the many loose boundaries in which it operates. The reason Air-Stream barbeque meetings attract such a large crowd in comparison to an average meeting is only partially for the food, and has more to do with what Thomson (1999) calls the 'social framework'. In view of this, the barbeque does not simply provide a convenient meal before the start of wireless work, it is a vehicle for wireless work. The barbeque provides the context in which wireless activities take place. It transforms the quadrangle from a primary school into a volunteer community WiFi group event. As a result it does not matter where the barbeque takes place, who cooks or what is on offer. The food is not as important as the non-formal, open and inclusive social space that it fosters, which evokes the question: Why might such a social framework be important for Air-Stream's WiFi network and what role does it play in the culture of Australia's backyard technologists?

Because WiFi is a technology that depends on connecting independent nodes together to form a network, it holds that forming friendships with members is as vital as learning about the technology. Social relationships are thoroughly implicated in erecting antennas and maintaining network strength and connectivity. Thus, connecting to people is essential for finding ways to connect to the network. This accounts for why Kevin attends meetings even though it is technically impossible for him on his own to achieve a connection to the network. Likewise, it explains why Joel had already made contact with Ben, 'the node', nearest him, and also why Kerry did the same for him at the meeting. As I have shown, being connected or getting connected is not a singular, definite or easy achievement but rather must be constantly produced and reproduced. In view of this, the barbeque is a crucial aspect of the group and provides one reason why it features so frequently in connection with WiFi events throughout this thesis.

Another reason concerns the traditional gender identity of the Australian barbeque. Further to the idea of the barbeque as a social framework, many writers view the Australia barbeque as a highly masculine ritual in which nature, in the form of meat, is hunted, tamed by fire and consumed. It is also a place, despite the increasing role of women in the workforce, where men predominantly take responsibility for cooking (Fisk, Hodge and Turner 1987; Thomson 1999; Skrbis 2006). Barbeques are also linked, in Australian cultural practice, to notions of 'mateship' and male sociality. Although the subject of significant critical reflection (Thomson 1994; Pease and Pringle 2001), mateship nevertheless remains an important trope in Australia's national identity (Duncan et al 2004), and is routinely reflected in Air-Stream activity and discourse.

The prominence of barbeques in the Air-Stream calendar also provides an unexpected vantage point from which to reflect on the composition of the community group. Although mothers, sisters, wives and girlfriends attended some of Air-Stream events, it was the male attendees who formed the core of the organisation. Perhaps Air-Stream's proclivity for barbeques can be explained in relation to the masculinity of the group and, given the challenging task that is WiFi networking, the desire for camaraderie and bonding provides guaranteed support and assistance.

In the computer room, at a meeting

> *We move inside to the computer classroom, one of the single storey stone buildings on the quadrangle next to the main car park and regular site for smaller monthly meetings. Eight by four metres inside with windows at the back of the room, a teacher's desk and projector screen at the entrance, the rest of the space is taken up with four rows of desks topped with bulky beige box monitors and keyboards, black chairs and a whiteboard on rollers. The board is covered in red and orange writing from the day's computer class. Names of children are listed in a numerical order and corresponding websites for them to explore during class. Colourful drawings and basic computer instructions line the walls above the terminals. 15 men, seven of whom I know and three women (including me) wheel chairs from behind desks into an uneven semi-circle facing the teacher's desk in the computer room. Because there is not enough space for everyone to sit side by side, some people perch on the edges of desks, between keyboards and monitors and in the aisles. The noise from clustered conversations in room slowly reduces and I look up from my small circle with Jane, Kerry and Kevin to see Tim talking at the whiteboard with a marker pen in his hand. I can't believe I have missed yet another start to a meeting! (Field notes 28.01.07).*

Like the barbeques, it was rare for Air-Stream meetings to start on time. It was also unusual for anyone to remain in the same physical position. Clustered conversations begun in the quadrangle continued inside meetings with individual threads merging into one and the meeting continuing from that point only to splinter a short time afterwards. Although an agenda was always posted on the website, it was never distributed in meetings, with the

exception of the AGM, and conversation instead meandered in different directions depending on who was in attendance, who was new, what questions were asked, the kinds of objects people brought with them, the recent weather and its effect on signal, what work had recently occurred or other relevant news. Trying to gain a sense of who was who, their role and relationships was difficult when people swivelled on their chairs, literally rolled into new groups, swapped seats altogether, stood up, leant over desks, or got up to talk or look at what others had brought to the meetings. It was a practice that enabled members to switch easily into different conversations or literally move to new clusters in the room, but it meant I regularly missed the start of meetings, the ends or beginnings of major points and other interesting chatter just out of earshot. As a result, my early field notes are punctuated with 'the conversation shifts', 'the meeting turns', 'following on' and my annoyance, as indicated above, about missing important points.

Guided by conventional ethnographic literatures, I read my inability to follow these twists and turns as a symptom, along with feeling overwhelmed and regularly lost, of my ethnographic apprenticeship (Hammersley and Atkinson 1996; Fetterman 1998; Atkinson et al 2002). It was not until almost a year later that I realised my major stumbling block was in trying to find some kind of neat trajectory as a way to make sense of it all. It was my narrow understanding of what should be happening that complicated my vision of what was actually taking place. It was not so much that I did not expect mess, as mess in ethnographic practice is standard and expected. Rather, guided by Latour and Woolgar (1979) and Henderson (1999) I hoped to narrow down and tidy up all of these co-existing and collaborating versions in linear and uni-directional 'chain(s) of transformation' or 'circulating reference'(s) (Latour 1999:70). I was seeking a gradually reductive process by which the messy texture of practice would somehow transform into a smooth, single and infinitely transportable series of facts. On a quest for singularity and order, however, I was initially blind to another way of understanding Air-Stream. Like Mol's multiple versions of the body, Air-Stream's culture is 'not a single passive object in the middle, waiting to be seen from the point of view of seemingly endless series of perspectives' (2002:5). Instead, there are many representations that connect people together, organise activities, shape transactions and interactions. Recalling de Laet and Mol's Bush Pump 'B', Air-Stream appeared 'solid and mechanical' and yet 'its boundaries are vague and moving, rather than being clear or fixed' (2000:225). Yet it is not chaotic or confusing. As evidenced by Joel, it is possible to navigate through Air-Stream's culture by 'attaching' to a myriad of representations. Coherence, as I will argue, is achieved through spatiality and time.

Designing for accidental discovery

> *Tim reminds us that the main point of the meeting is to talk about the new portal system that he 'slapped together' in time for the public IT Discovery Day held at the local community centre last weekend. He explains the version he will show is customised for the community centre but the idea is that people can put anything they like on it and configure it on a 'site-by-site basis'. Tim says the idea is to create an easy entry point to Air-Stream for new people who accidentally 'stumble' across it (Field notes 28.01.07).*

Air-Stream meetings are an important place where the group's culture is collectively rehearsed and encountered. As per the agenda for the February 2007 meeting, Tim 'demo's' the 'portal', which is an access point to the main network that appears on screen when a person with a WiFi enabled device enters an Air-Stream network area. The aim of the portal is to replace a stream of numbers and complicated code, which up to now has required sophisticated knowledge to decipher. Instead, it aims to graphically entice the 'stumbler' to want to learn more about the group. Thus, it will operate as a representation of, and entry point to, the Air-Stream network. It will connect people to the group. However, what Tim is talking about is not *the portal*, but software to produce an infinite number of portals limited only by interested members in the group who each will be able to customise it to the area in which they are located. Like the Bush Pump 'B', the portal is a specific piece of technology, yet the *way* it works is 'not a matter of interpretation' as de Laet and Mol write, it 'is built into the technology itself' (2000:225).

Designing for people to accidentally 'stumble' across the portal highlights the challenges Air-Stream members face. Representations made by Air-Stream members have to work much harder to attract the attention of a heterogeneous audience of non-IT experts. While the presence of contrasting Air-Stream merchandise in the quadrangle may seem co-incidental, the portal is a representation of the network that has been deliberately designed to be mobile *and* mutable. In STS, representations mark the point of stabilisation, the end of a 'chain of transformation' in which information has been unified, yet what Tim is presenting is a representation of the network that will never reach this point because it is deliberately designed to remain open to interpretation and adaptation.

Air-Stream members are enticed to participate not only by using or hosting the portal but also by *making their own version*. Their role is key to how the portal and, by association, how the network works and suggests that like de Laet and Mol's pump, the network is 'nothing without the community that will serve it' (2000:235). The diversity of portals offers alternative entry points into the group and with each iteration the network gains in strength. Thus differentiation and distribution, far from weakening it, makes Air-Stream stronger.

The 'myth' of order

> *Tim says he is going to 'get to the guts of it' and turns to the whiteboard which is covered in red and orange instructions from the day's computer class. Although a whiteboard cleaner sits on the lip of the board, Tim flips the board so the orange and red writing is inverted and he begins to draw over the top with a blue pen. As he talks, he draws and simultaneously answers questions from the group, which prompts new directions of diagrams and text on the board. Soon it is covered in a mishmash of orange, red and blue lines, text and sketches (Field notes 28.01.07).*

For Air-Stream, information does not flow; it clusters, overlaps, stumbles, tangles, pauses, and stops and starts as people call things out (Figs. 19, 20, 21). Tim drew as he talked. Each line, written word and box echoes his interactions with the group. Interweaving words, drawings, questions and answers into the representation of the portal, he designed the demo along with his audience. His demo took form in line with levels of knowledge in the group and the flow of conversation. Unlike a science lab or engineering office, Tim's audience is made up of 'originals', 'officials', 'tourists' and 'newbies', trained graphic designers, 'techies', ham radio amateurs, researchers, computer scientists, IT specialists and others with unknown interests. To contend with this variability he highlighted multiple entry points into the portal, asked and answered questions and repeatedly scanned the room for feedback. It was Tim's demo and a collaborative representation. As a result, I found it challenging to take field notes because the diagram only made sense at that specific period of time. It was too dynamic to capture in a flat two-dimensional medium to be read later. It was contingent on clustered chatter, other noise and movement. As a result, the diagram in Fig. 19 is hard to read and impossible to understand after the event, notwithstanding the fact Tim annotated a white board already inscribed with red and orange notes from the primary school computer class. But this assists my point about the temporal conditions of Air-Stream's representations. The demo is not about the final diagram. It is better considered a live and dynamic representation of the network that grew out of an experience at the meeting. In this way Tim's actions echo what Henderson (1999) has written about the 'myth' of natural flow of information. Similarly, in science Latour and Woolgar have shown the 'struggle to produce order' in the laboratory (1979:36). Yet, unlike Henderson's engineers and Latour's scientists, Air-Stream's participants are more willing to put their messiness on display – in fact disorderly representations of WiFi are critical to the group's functionality. As the demo continues even more disorder is revealed.

> *Tim asks Dan, seated behind the teacher's desk, to 'give the site a whirl'. Dan opens his laptop connected to the projector and a screen comes up on the wall behind him. We see a row of simple navigational boxes down the left hand side with small boxes of type in the centre. Apart from the Air-Stream logo at the top, nothing else reflects the current website. Someone says it is hard to read in the brightly lit room. Kerry switches the lights and the room plunges into a*

grainy darkness, lit by the glow of the screen and five laptops. Tim assures us that it is easier to read on a computer screen and the all laptop users agree. Tim tells us we have been looking at 'the front end' and asks Dan to 'show us some of code for those of you who are techie'. Suddenly, the graphic screen is replaced with lines of code. The 'techies' ask questions about it and Tim walks up to the screen to point out answers (Field notes 28.01.07).

Tim's demo started with a diagram on the whiteboard, moved onto the computer and projector screen to the visual front end and then to the coded back end, in bright light and then darkness. Those with laptops in the audience were encouraged to navigate the portal on their own, moving to and from pages directed and undirected by Tim. At this point, the Air-Stream portal was present in multiple dimensions.

Dimensionality is an important component of Air-Stream representational practices and there are strong echoes to the practices of a range of scientists, engineers, doctors and designers in STS literatures (Martin 1994; Henderson 1999; Latour 1990; Sturken and Cartwright 2001; Yaneva 2005; Myers 2008). Although these studies encompass two and three-dimensional representations of knowledge, Air-Stream members' co-located multi-dimensional practices remain striking. They take two-dimensional (photos, maps, website, diagrams), three-dimensional (t-shirts, antennas, events and demonstrations) and sometimes no dimensional form (electromagnetic signal). Moreover, as illustrated by the incidence of varying logos on merchandise and the mutable design of the portal, these multi-dimensions are prone to change. This is further evidence that Air-Stream's representational culture does not work in 'cascades'. Instead, what emerges is the idea that many multi-dimensional representations appear to operate simultaneously.

Henderson's (1999) engineers provide another interpretive lens in the form of the 'yellow brick road to production' whereby 'Dorothy and her colleagues, follow a promising path but encounter unexpected happenings along the way' (1999:59). Although this model is more useful than the scientific one for understanding the tangents and entanglements that attract and distract Air-Stream members inside and outside meetings, it remains, like science, ostensibly uni-directional and relies on hierarchy and status to resolve conflict. As the design of Air-Stream's portal makes clear, there is no single road that everyone must follow and while Tim might be a presenter he is not accorded higher status in this role. Air-Stream's meeting practices are very much geared toward participation and collaboration rather than a single directed outcome. They are characterised by multiple paths that divide and tangle, and occasionally merge back together or run in parallel.

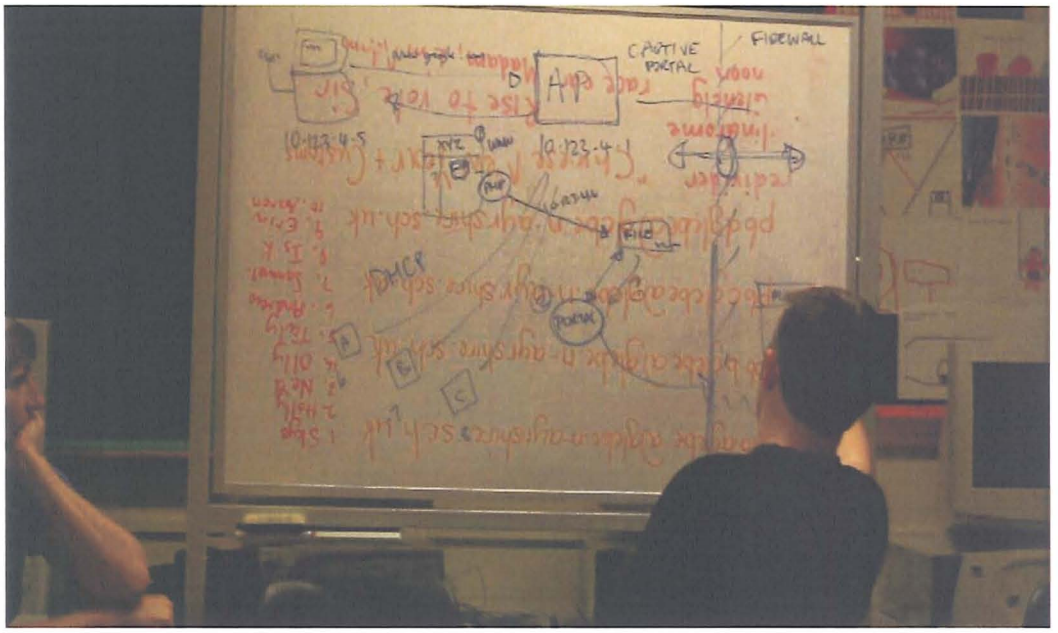


Fig. 19. Tim overwrites on the white board (28.01.07).

Fig. 20. Tim 'demo's' the portal on the whiteboard, on the projected screen and on laptops (28.01.07).

Fig. 21. Turning out the lights to see the projection of the portal in more detail (28.01.07).

Abandoning control

> *Someone asks about how the portal will handle a lot of users and Tim says that it held up 'quite happily with six machines hammering it in the demo room' and suggests that people with laptops can try 'hammering it now'. The sound of typing fills the room. Tim asks Dan to go to the 'guest book' to show how visitors can leave comments. When he does, he laughs and points out that 'Drift' is already there. Drift is a member who is not at the meeting but has logged in to the portal via the Air-Stream network from his home. On screen we see his comment, 'Drift: Say hi to everyone at the meeting for me.' Everyone laughs and Simon says that he too has signed the guest book during the meeting. Dan refreshes the screen and we can see Simon's, 'Hello everyone' which causes more laughter (Field notes 28.01.07).*

Using the portal's online guestbook even absent members can contribute and participate in the meeting, further emphasising the multi-directionality of Air-Streams representations. Others with laptops may be physically in the room but are 'hammering' the portal, and the rest of the group divide their attention between the whiteboard diagram, the projection on screen and clustered discussions about individual designs. Tim appears no longer in control of the meeting, if indeed he has been in control all along. This example illustrates in practice what he earlier described as his method of 'visual attachment' that does not so much establish a single focal point, but many. After introducing a variety of ways into the portal for people to 'visually attach', he now stands back. Rather than trying to create order, limit diversions or control the 'demo', Tim sticks diverse skills and interests together to co-create the portal. He may have designed the original portal but the noise and clustered conversations in and out of the room indicate he is no longer central to it. Instead, like the designer of the Bush Pump 'B' he has managed 'his own dissolution' (de Laet and Mol 2000:250) and does not claim authorship or attempt to control the portal. Here a successful technology does not require a central, dominant or assertive figure in a fixed and unchanging boundary. As de Laet and Mol argue, a lack of order and central control can lead to successful technology that is strong precisely because it fluidly adapts to changing circumstances. They write: 'Sometimes abandoning control may contribute to spreading what one has been making' (ibid). Although the inventor of the Bush Pump 'B' was unconcerned with how the pump was adapted, fixed and changed, Tim remains a co-creator in the portal's future.

This provides a striking comparison to Latour's (1988b) writing about Louis Pasteur who is characterised as a dominating figure controlling the network (Martin 1996; de Laet and Mol 2000). In other words Latour's actor imposes himself *upon* other actors. The difference is that he *builds* a network rather than being *part of* a network. de Laet and Mol also take this perspective suggesting that Latour's Pasteur deliberately hides the work of the other actors in order to 'emerge as its prime mover' (2000:249).

In an interview a few months later, Tim expressed his thoughts on the demo. It is clear he does not see himself as a Pasteur – instead he is interested in strategies for encouraging greater participation, co-creation and sharing of ideas.

> T: I don't think it was ideal. Now I could do a better one.
>
> K: Why wasn't it ideal?
>
> T: Minor details. But as far as getting the idea across it did its job. I mean the main concept is that when you log in you gain access through the firewall and that's what I was trying to show. I didn't know that I was going to go into that much detail about all the other components. Some of the guys there would understand that, some wouldn't. I was just going to play it by ear. As you know, I am always kind of doodling those kinds of diagrams anyway when I'm talking to people. You generally get an idea for it after a while (Interview with Tim 08.03.07).

'Playing it by ear' is Tim's description of being open to change even when you are presenting a new concept in front of a group of people. The fact that he would do a 'better one' next time indicates that there is no single way of explaining the portal and no one-way of showing it. Even as the central author, even he is not *stuck* to a single form of representation.

The crucial point to glean from Tim's 'demo' is how representations in Air-Stream do not *glue* or *link* people together in hierarchical sequences as illustrated in science or in engineering in STS. But this does not mean they are not sticky. I suggest that people adhere to Tim's presentation on the white board, on the screen and on personal laptops. To use Tim's words, they 'attach' themselves to it. The difference lies in the fact that it is not a universal stickiness or myopic view. No one is bound or stuck to a single representation, even the designer himself. Instead, the portal works because of Tim's informal and open approach to its design and the group's eagerness to participate and contribute.

Air-Stream WiFi and productions of masculinity

At the barbeque I noted the presence of three women (including me) in a group of thirty. Similarly I mentioned it again in the meeting. This time there were three women in a group of eighteen. Even though Jason and I had never met face to face, he identified me at the barbeque. Although this can be explained by a small photo of me on the website, he was no doubt assisted by the fact that among the new faces at these events, there are few new female ones. Another example helps to illustrate this point. During a break in one of my early meetings as I was name-checking attendees in my notebook, I asked a member seated near me to assist. He helpfully listed names of people seated in the rough semi-circle until he got

to Jane whom he referred to as 'the female' along with her name. The fact he had not called the others 'the males', singled her out in the group by her gender and shows I was not the only one aware of the imbalance. Earlier, I also noted the masculine characteristics of the barbeque, rooftops and IT. Explicitly or implicitly, gender is present throughout my study, even though as indicated in Chapter Two, guided by STS literatures and ANT, I did not initially set out to study it. Yet, here a question is raised: Does Air-Stream recognise the maleness of its membership and does it produce masculinity in the group?

Many of the Air-Stream's activities are open, inclusive and welcoming; events are held in the public school and community centres and emphasise sociality around technology, information about the group is published on the internet and membership is not deemed essential with new people encouraged to attend meetings. Yet, barbeques, as discussed previously, have masculine overtones and meetings take place on weeknights when family commitments might interfere with WiFi activities. It is interesting to note that none of the three women involved in Air-Stream had demanding childcare duties. Only Jen had children and they were older, at twenty-five and twenty-seven years of age. In contrast, the male members were either young and lived at home, which meant many of their daily routines were shaped by family structures, or were older and if they had children they were primarily cared for by their female partners. In fact, out of three women in the group, only Jen was an 'official member' because Jane self identified as a 'tourist' and I had been granted temporary 'honorary' membership for my field work. This meant that Jen was the *only woman* in a group of 70 male members, not all of whom attended meetings but paid their fees, used the website and the network. Thus, like Mol's (2002) doctors, it became spurious for me to continue to refer to 'members' in my fieldnotes when I actually meant men who were members of Air-Stream.

One possible implication of this is that Air-Stream's version of WiFi is for men. Even when the girlfriends, sisters or wives of Air-Stream members dropped them off or came to pick them up after events or meetings they did not linger. On one occasion someone's girlfriend even sat in on a meeting, a few seats away from the group, and read a book. The reason she gave for not joining in? – 'Not interested'. Others talked about Air-Stream as 'not my thing'. But as I gradually learned from members many of the women in their lives *were* interested in using the network once it was up and running in their homes, which suggests there was something about how WiFi is made by the group that alienates them. An interview with an Air-Stream member is revealing for this reason:

> My sister loves Air-Stream heaps. She browses a lot of people's FTPs [uploaded content] and stuff. She doesn't really involved in the talking to other people because she's not really involved in the Air-Stream type of thing but she definitely does get a lot of downloads (Interview with Ben 08.03.07).

Guided by feminist literature outlined in Chapter Two, and with specific reference to Faulkner (2000) who examines how engineering 'sticks' to men, I continue to explore how Air-Stream's WiFi 'sticks' to Australian men in the following chapters.

Conclusion

One conclusion that can be drawn in this chapter is that Air-Stream's culture holds the group together, even when the reality of wireless network is altogether much more disconnected and disordered. This conforms to earlier arguments about the role and importance of representations within STS of science and engineering (Latour and Woolgar 1979; Henderson 1999). However, upon closer inspection it is obvious that something else is going on. The way they do this is not ordered in ways outlined in the literature. Specifically, the representations Air-Stream members make do not subscribe to the same rigorous 'assembly lines' (Latour and Woolgar 1979), slot neatly into hierarchical 'cascades' (Latour 1990) or follow a winding 'yellow brick road' (Henderson 1999). This is because there are a lot of them, they are manifest in multi-dimensional modes and multiple authors are involved which means they co-exist and in some cases, contradict each other in the same place. I have also shown how the use and production of representations are not determined by physical or temporal boundaries, such as the walls of the classroom or start or end of meetings. What is clear is that there is no one, single or dominant way of representing the Air-Stream network.

In striking contrast to the role of graphs, images and sketches in science and engineering that seek to impose a linear and rigid order on people and their practices, Air-Stream's culture shapes, and is shaped by, the idiosyncrasies of the technology, the location and the nature of the group. My account of representations in the form of maps, websites, antennas, barbeques, t-shirts, bodies, demo's, websites, shirts, photos and fundraising tins at Air-Stream meetings all challenge conventional definitions of what is considered legitimate representations of knowledge. Yet I have shown how the peculiarities of Air-Stream's culture aid recruitment and participation irrespective of the reality of technological connection. Similarly, the co-existence of contradictory logos illustrate how several ideas can survive and co-exist which creates space for both the tentative encounters of 'newbies' as well as the daily interactions of established 'official' members. As a result, Air-Stream's

scattergun style of visual representations provides something for a diverse membership to 'visually attach'.

In view of this, the representational culture of the group does not 'impose itself but tries to serve' (de Laet and Mol 2000:226). Like the Bush Pump 'B', and contrary to the other science and engineering representational models, the Air-Stream network is easily picked apart, unravelled and customised. Elements can be swapped over, new links replaced and others easily adjusted. What this means is that Air-Stream's representational culture does not need to be stringently ordered, impose itself on or demand conformity of those it surrounds in order to produce a successful technology. Indeed Air-Stream's inclusive and non-imposing culture appears to be as persuasive as more traditional ordered models. However, unlike the Bush Pump 'B', the culture of the network is not fluid. It does not flow from point to point. Representations are not standard and change shape according to different circumstances and conditions. As made clear by Air-Stream's portal, it is made that way from the beginning. Disorder does not simply happen to the network. It is built into it. It is part of the design.

Chapter Five.

Representing interruption

According to ANT, systems achieve stability when disparate human and non-human actors accept an assigned role in a complex heterogeneous network (Callon 1986, 1987, 1997; Law 1986; Latour 1990, 1991, 1997). The Air-Stream network is clearly stable. It has operated for over six years and continues to grow in size and strength. It also has, as I have shown, an established visual culture. Yet, members encounter a vast array of interruptions on a daily basis such as trees, birds, bugs and possums, technical complications, a myriad of materials and the weather. I show how rather than tidying up and smoothing out these disturbances, members build them into the network. In this chapter I explore the possibility that it is the group's ability to deal with constant indeterminacy and multiple realities that affords it durability. From this position, I argue that Air-Stream make WiFi not in spite of interruption, but because of it.

The co-existence of stability *and* instability

In the introduction to this thesis, I described a series of thefts that resulted in the loss of core nodes from Air-Stream's network. The owners were away on holidays and Dan was the first to discover a problem with the node at *Skye*, one of the twenty-two major 'backbone' nodes in the network. He explains what happened:

> I just thought it had crashed. So I just waited a couple of days to see if it would fix itself. Then I was just on my way down to the bakery. I picked up a pie and on the way home... I live here [points just above *Skye* on the map]. I thought, well, *Skye's* on my way home, I'll just drive by and restart it. So I drove there, got out of the car and walked down the driveway and it was like – the routers gone, fuck! I thought maybe Ron took it down or something. Maybe he went up, it crashed and he couldn't get it started. So I hoped for the best. But... yeah, not! I immediately went home and sent off a couple of emails and stuff (Interview with Dan 4.03.07).

The fact Dan went to the site 'after a couple of days' and 'on the way home' from the bakery clearly tells us he did not anticipate theft. Instead, his response suggests that 'crashed' nodes are a mundane and commonplace event. Furthermore, the possibility that the problem might 'fix itself' points to an acceptance of these and similar interruptions. Although theft is a relatively uncommon event, it is clearly not the only one that members contend with in the making of WiFi. Instead, interruption appears to be a common theme in daily experience of the network.

Star (1999) has argued that infrastructures are often ignored and hidden until something goes wrong; interruption brings to light behind-the-scenes activities ordinarily taken for granted. She writes: 'The normally invisible quality of working infrastructure becomes visible when it breaks; the server is down, the bridge washes out, there is a power blackout' (1999:382).

Yet, in Air-Stream's case, the infrastructure of the network was evidently visible to thieves prior to the theft, in maps on the website and in the suburban roofscape, and Dan was the only one within the network to suspect a crashed antenna. Contrary to what we might expect of a small, independent, backyard technology network suffering the theft of a key backbone antenna, the network did not spectacularly fail or break down. It did not disconnect every member from their file sharing, game playing, up or downloading activities. In fact, many members did not even notice a problem. It was not until Dan actually went to the site and physically discovered the equipment missing that an alarm was raised. As a result, this account offers a striking contrast to what has been written about how even the smallest interruptions can cause immense disruption to infrastructural systems (Collins and Pinch 1982; Callon 1986; Star 1991; Ackrich 1992; Latour 1999). For instance, Star's (1991) allergy to onions illustrates how a simple request to change a McDonald's burger creates a significant mechanical blip. Instead of taking the standard five minutes to prepare, she waits for more than 20 minutes and reveals how even a tiny deviation can interrupt and paralyse a standardised normative system. Further to the loss of a node being an inconvenience, the controversy in this incidence lies in the possibility that thieves might be using the public visual culture of the group in unofficial ways. What Dan's account reveals is the network as a site of instability *and* stability.

To explore this aspect of the network, I draw on STS literature that highlights the possibility of co-located complex and contradictory realities (Singleton 1998; Mol 2002; Law and Singleton 2005). Singleton's study of the role of the lab in the UK cervical screening programme (CSP) provides a useful lens for examining how it is possible for stability and instability to co-exist and contribute to the success and durability of a system. She argues that, 'ongoing instability characterises and lubricates the continuation of CSP' (1998:102). In Dan's account, instability is implicit in the heterogeneous network that makes up Air-Stream's WiFi infrastructure. As this incidence of theft shows, the network is never fully known by anyone. While one member might experience technical difficulties, another will have no issues whatsoever. Yet, as argued in the last chapter, the group has developed a thriving culture that connects people together, aids recruitment and the development of new applications of the technology. Therefore this chapter asks: What relevance, if any, do visual representations of Air-Stream's network hold in these contradictory conditions? What value do they have if ambiguity is not erased and stabilised? What might constant interruption teach us about technology innovation and knowledge practices?

In order to gain a sense of what this provocative paradox - representing interruption - might mean, this chapter starts by examining in detail the stable *and* unstable characteristics of the range of actors engaged in the complex heterogeneous network involved in making WiFi in the suburban backyards of Adelaide. It then explores why this seemingly incompatible combination gives rise not to anxiety or fragmentation but innovative and resourceful solutions that shape and in turn are shaped by the group's culture.

The problematic and productive presence of trees

Because WiFi is predicated on the visual line of sight (LOS) between antennas in the network, this means that two points need to connect to each other in order to transfer data. If anything gets in the way, the signal is interrupted or blocked (Fig. 22). For WiFi community groups in the more architecturally dense cities of Barcelona, London, Portland and Berlin[25], blockages between points in their networks are most often caused by new tall buildings that alter the physical landscape and thus reconfigure the digital landscape. In Adelaide, however, significant urban development is relatively rare and the cityscape is relatively flat. Trees, however, constitute an entirely different matter. Adelaide's extensive parklands, green belts and old suburbs are characterised by mature trees. Negotiating passage over or between ubiquitous leafy blockages is an integral part of how Air-Stream makes WiFi. Unlike buildings however, the fact that trees are *never* static, but are constantly growing in size and changing in shape renders them a constant source of instability.

In Chapter Four, I drew attention to multiple co-existing types of connections in the form of members who were unconnected, disconnected and trying to get connected. Figure. 22 further fragments these categories with the possibility of LOS as well as 'near' and 'non' connections, which evoke the questions: What is a 'near' connection? Does this mean it is possible to be *almost* or *sometimes* connected? The following examples attempt to answer this by illustrating some of the stable and unstable roles trees play in the network.

At the November 2006 barbeque, Joel, a 'newbie', admitted he had not joined the network because of 'time, trees and apathy'. The very presence of a dense wall of trees around his house made him feel overwhelmed. Kerry and Jane are also aware of trees in their suburb and they have established their presence as a problem. Despite trying for a year they are still unconnected. Kerry explains:

[25] See http://consume.net, http://wirelesslondon.info, http://bristolwireless.net, http://personaltelco.net, http://cuwireless.net, http:friefunk.net

> It was wintertime and in our lounge we had this little cantenna, a home-made thing on a stick up near my window and it was this dodgy piece of crap which was like pointing somewhere over there [corner of the room] and if we didn't touch it, it worked, but as soon as we touched it, it didn't work, so we left it alone. Then we get up on the roof - nothing! It was really frustrating. From our lounge there are trees and other stuff and then we get up on the roof and it's clear and hopefully we are just above trees and we couldn't get a thing. And I had at least a dozen attempts up on the roof with bigger masts and better antennas. And nah! [nothing]. Once on the roof I got a couple of packets and nah [nothing] (Interview with Kerry 23.02.07).

Getting a 'couple of packets' meant Kerry established a connection with a nearby antenna in the Air-Stream network long enough to share short bursts of data, but it was neither durable or stable. His account highlights the discrepancy of connection in relation to seasonal change. Even though he briefly achieved a connection when the deciduous trees shed leaves, he experienced problems in summer once the foliage returned. Thus, he achieved a 'near' connection in winter, provided he did not touch the antenna, and a 'non' connection in summer. In addition to growing in height, trees also change in volume.

The location of trees and their seasonality also pose issues for Jen, an experienced ham radio operator, but her connection is unsettled by the time of day that she tries to connect.

> It was working until the sun went down and then it dropped out and it didn't work all night and then next morning I turned it on again and it didn't work until the sun came up and in the middle of the day it also dropped out and I've being trying to figure out why that might be. I've talked to an amateur friend of mine and (...) we think it's to do with something in the trees. Trees might get damp in the evenings and at night, which might cause attenuation of the signal. Whereas during the day especially at the moment they dry out and that would tend to match with the fact that during winter I couldn't really get a connection at all (Interview with Jen 04.02.07).

Daz, a 'committee member', did not even notice the trees in the golf course near his parent's house, until they started to interfere with his connection to the network. He set up his node in 2004 on the roof of his parents' house, nine metres above ground level. With this height, he achieved a connection across the park to another Air-Stream antenna. Every year, however, the trees have grown and recently started to cause his signal to 'drop out'. This, however, is not a straightforward problem. Firstly, it 'comes and goes' so it only happens occasionally. Secondly, there is also a 'good thing' about the trees; they stop him from hearing all the 'truckies' [truck drivers] who share the same radio frequency. His friend on the other side of the golf course is not so lucky and regularly 'cops it' in the form of abuse (Interview 07.03.07). The trees interfere with his signal, yet they also filter irrelevant 'noise' on the spectrum. This means his connection is sometimes good, sometimes 'near' and occasionally 'non'-existent. Moreover, Daz is aware that this range of connection is only temporary as the trees continue to grow. At some point soon he knows he will have to build a taller mast or connect to a different Air-Stream node.

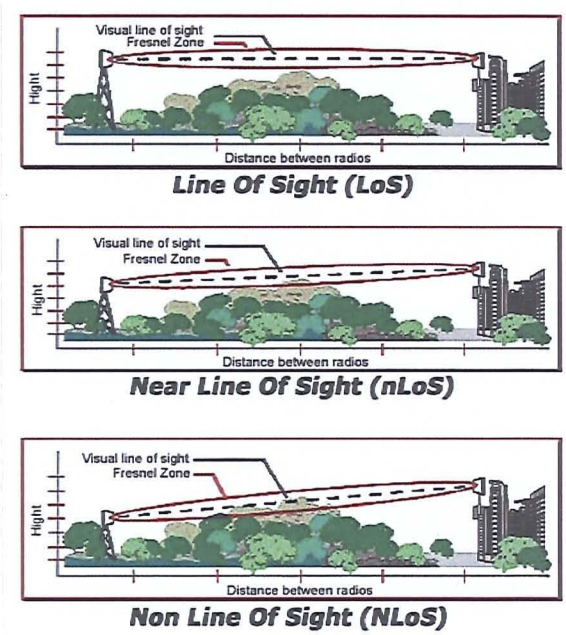


Fig. 22. Diagram of how line of sight (LOS) connection operates in a WiFi network (Accessed 10.10.06, Available at: http://www.air-stream.org.au/los).

Reg, a 'committee member' in the group, provides another example of how trees simultaneously complicate and contribute to the network. Living at home he was more than aware of the dense eucalyptus bush that surrounded his mother's single storey house in a steeply landscaped northern outer suburb of Adelaide. However, rather than viewing it as an obstacle he built his antenna into one of the biggest trees. Although he had already connected to the network via an antenna on the roof, he wanted to 'go higher' in an attempt to make the connection more 'reliable'. At thirteen metres in height, the biggest tree was located fifty metres from the house on an elevation ten metres above the driveway. At the top, Reg found himself twenty three metres in the air, which he said felt like 'looking down from a helicopter' (Interview 6.03.07). Up there, his view across the west of the city suddenly 'opened up'. Ingeniously, building the node into the tree significantly reduces the likelihood of experiencing the same problem as Daz. The node will not be blocked by the surrounding bushland, because it grows with the tree. This solution, however, does have its drawbacks. Consider how Reg describes his new antenna in terms of stability *and* instability:

> It was fairly rigid up there after I put in the guy wires and the link to the water tower [a nearby Air-Stream node] has always been solid. (...) The pole only goes 13 metres up the tree. It's not as rigid at the top of the tree. There is more flexibility and with the cable going up there, it creates even more loss (Interview with Reg 06.03.07).

The antenna may be stabilised in the tree but the tree retains unstable characteristics; it sways in the wind. Moreover, as I will discuss, there are additional interruptions in the form of birds, bugs and the scorching effects of the sun. Regardless of a person's status as a 'newbie' or established 'committee' or 'official' member, these accounts reveal the critical and constant role trees play in the making of WiFi. Unlike the animals and chemicals that enter the laboratory and form the basis of many scientific experiments, trees cannot be coded and conveniently catalogued in the construction of knowledge. They cannot be contained, neatly cleaned up or stabilised because Air-Stream's WiFi is firmly embedded in Australian suburbia. The constant instability of the treescape reveals the impossibility of a stable connection. In the last chapter, I highlighted how connection to the network is not a prerequisite for joining the group and nor is it guaranteed as part of membership. Now, it appears that even when it is achieved, connection is never stable. These accounts of connection as 'near', 'non', 'sometimes', 'only in the morning', 'in summer' and 'when there is no wind' signal temporal disjunctions. How then do members deal with connectivity that can only ever be considered intermittent and temporal?

The sun and sunburnt technology

> *Simon, Craig and I walk to the carpark to help Ron unload equipment from his car. Craig asks him what he brought and looking inside the boot it was easy to see what he meant by 'pretty much everything'. In fact, it was difficult to see how he managed to close the trunk. Several plastic buckets overflowed with cables and cable ties, dishes, steel brackets, modems, sticky tape, nuts and bolts, drills, hammers, saws and pliers and much more concealed beneath these objects. Digging through, Ron extracts a small, discoloured modem. Pointing out the blotchy yellow markings on the once beige plastic skin he says its 'sunburn' (Field notes 16.09.06).*

Adelaide backs onto the desert and fronts the Southern Ocean. This means that the city experiences mild winters but searing hot summers. With almost nine months of sun a year, antennas located on suburban rooftops, trees, sheds and factories are almost constantly exposed to its searing strength and members are used to dealing with the force of temperatures that reach over forty degrees Celsius. In these temperatures computer plastic burns; it discolours, dries and begins to peel. Ron kept a modem on the roof for a while – it did not take long for the casing to discolour and singe. Despite how it looked, however, Ron said it still 'worked'.

> *Craig then tells a story of a modem that looked 'much worse than that'. He once put a modem in a 'Tupperware*[26] *container' that he 'found' in his mum's kitchen and then 'stuck it on the roof'. The plastic apparently lasted for a few months but it could not cope with prolonged*

[26] *Tupperware* is the name for a range of popular kitchen storage products made of hard-wearing durable plastic.

exposure to the sun, and eventually 'crumbled' (Field notes 16.09.06).

These accounts highlight the climatic challenges that members deal with on a daily basis. Nothing can be done to protect computer equipment against the Australian sun over long periods of time. Instead much like the treescape, members resolve this particular consequence of the Australian climate by employing increasingly imaginative combinations of materials that simultaneously serve to demonstrate personal ingenuity and resourcefulness. Reg's tree node is a key example of this. Although he avoids the problem of the trees interfering with his connection because his node grows *with the tree*, he has to contend with a new range of challenges. Even if the antenna box can be located out of direct sunlight, the heat from the sun is problematic for the computer equipment inside. To counter this, Reg used a specially purchased metal box, the type used for fire systems in buildings, however he has extensively customised it beyond its original design. He drilled holes, in the side and the bottom of the box, and glued two PVC [polyvinyl chloride] plastic pipes provided by a family member who works at a winery. Because PVC pipes are very expensive he says he was 'lucky' they 'found heaps of it laying around'. The top tube was chosen specifically for its shape, curving at an angle so to provide ventilation but impede rainwater. With two steel poles, a combination of Hills Hoist (clothesline) wire bought from the local hardware shop and fencing wire 'found' in the shed, Reg secured the box using a 'spiderweb' of chains and u-bolts into the uppermost branches. As a result, setup is uniquely shaped according to the materials he 'found' coupled with sensitivity to the context of use.

For Reg, getting connected was not just work – his custom solution was a source of both pleasure and pride. Coupled with references to 'playing' with technology highlighted in Chapter Four, accounts like this reveal the *fun* Air-Stream men have in making WiFi. This is striking, because infrastructure is rarely associated with fun. As Star (1999:377) has argued, it is more often considered invisible or 'boring'. Yet Air-Stream members clearly value fun and the pleasure of making connections. A case in point is provided in the following interaction. At a meeting, members were discussing problems with a local ISP who had accused them of 'polluting' the shared wireless spectrum.

Ron says it is 'meant to be fun'. And that this is 'taking the fun out of it'. He says it 'feels like work' and 'that is wrong' (Field notes 18.08.06).

Ron clearly views fun and work as oppositional. Interviews with Air-Stream members identified a clear thrill and pleasure deriving from tackling an ever-changing series of challenges and problems with new and creative solutions. Putting an antenna in a tree for

instance generates its own unique series of problems and thus opportunities to play with the solutions. Yet this sort of playfulness is not a strong part of STS. As Kleif and Faulkner note, 'stories about technology as fascinating and fun are rarely integrated with stories of the social shaping of technology' (2003:298). Moreover, they stress the importance of understanding what drives people who make technology in order to understand how our technologies are made and could be made differently. Individual experiences, attitudes and biographies are important aspects of any technology story. For the men of Air-Stream, a sense of pride and achievement clearly accompanies incidents of shared story telling in the group. In this context, climatic instability in the broader WiFi network appears to catalyse experimentation, which brings about positive social interactions and feelings of pleasure.

Bugs, birds and the 'gully wind'

'Bugs' are another group of actors that Air-Stream members have to work with on a daily basis; that cannot be neatly catalogued, controlled or erased from the final system. Anyone who has spent any time in Australia in summer is keenly aware of the presence of an abundance of insects. With over 220,000 different species, small things that fly, jump, crawl and bite are a mundane part of everyday Australian life. Although boxing up equipment serves to reduce the effects of sunburn and heat, it also means members have to find ways to prevent insects from nesting inside their equipment and housing.

While some members use sticky tape or cable ties to firmly keep box lids in place, the most popular material is 'flyscreen', cut into small pieces to cover ventilation holes. More familiar on the swinging front door of an Australian suburban house, flyscreen is a small gauge gauze mesh. Air-Stream members extend the use of this material to keep all manner of insects out of their WiFi equipment. Here, a familiar piece of suburban living finds its way into a newly developing digital technology. The innovation Air-Stream members make is clearly shaped by the use of local materials coupled with a nuanced understanding of the landscape. As Goggin has argued, it is important to 'see the novelty that different cultural contexts bring to bear on our own normative understandings and expectations of a given technology' (2007:44). My point is not only that these materials work effectively in these new applications, but that members are also open to viewing them in new ways.

Birds are also regular actors in the network. Evidence of how local fauna is accommodated in everyday life can be found in street signs installed all over the city (Fig. 23). Further to warning human inhabitants about the presence of birdlife, that 'swoop from above or below'

they advise keeping away from this area at certain times and how best to avoid provoking an attack. It is clear that part of living in the city involves co-habitation with local bird-life. This goes someway to explain Tim's casual acceptance of the fact that he received a text every time a bird sat on an antenna connected to his temporary alarm system at the factory. Unlike bugs, birds are not something that can be readily ordered, repelled or controlled.

Beyond bugs and birds, Air-Stream's WiFi network has to contend with other sources of climatic instability. The rugged tree covered landscape of the Adelaide Hills has a distinct influence on the weather and, in turn, what kinds of wireless work is necessary and when it is undertaken.

> *Ron yawns and apologises, saying he is very tired. I ask if it is due to his baby son, who he has told me is not yet sleeping through the night. He shakes his head. 'Gully wind'. 'It is really loud around my house'. I ask him what it is. He looks surprised that I don't know. He explains that gully wind is very 'scary' because it is a 'blustery' wind, and a big gust can 'make you tumble off a roof'. This means that sometimes what seems like a good time to go up to the roof and fix an antenna changes when 'up comes the wind' (Field notes 09.11.06).*

'Gully wind' is a local name for a particular summer weather condition generated from cold air rushing down the hills into the gullies and out along the plains and it is not just loud, it is also dangerous for wireless work. Reg's tree node was deliberately designed to accommodate local winds around his house. Using various types of wire he fastened the pole to the tree trunk and chains that looped through the box and around the branches. This method is apparently so effective he can stand on it 'like a platform'. However, despite the solidity of the setup in the tree, he has little control over the force of the wind on the tree itself. The wind makes the tree sway which in turn makes the node less reliable than if it was affixed to a building. Reg says, ' Once it was extremely windy and it felt like it was going to snap. It was moving half a metre side to side' (Interview 19.07.08). The propensity for this gusty, unpredictable wind serves to shape when wireless work can take place and also how antennas are built and installed.

Fig. 23. Street signs in central Adelaide city streets alerting locals to presence of wildlife (12.08.07).

What emerges in these accounts is ongoing relationship between technology and the specifics of the environment in which it is placed; a developing and shifting conversation between the many actors involved in making WiFi. They provide a clear indication that members acknowledge realities that exist 'out-there' (Law 2004). Rather than attempting to order actors into a stable, linear relationship and construct a single definite reality, Air-Stream members are constantly adjusting and adapting to changing circumstances and *work with* instabilities.

A 'cocktail' of technical problems

When Dan recounted the Air-Stream network crash he initially attributed the problems to technical elements of the network. As Mackenzie writes: 'Of all the wireless networks, most of which are not more than a decade or so old, the most unstable, the most prone to sudden proliferation or contraction, might be WiFi wireless networks' (2007:95). Because there are no wires to trace and coupled with the heterogeneous network of actors involved, there are infinite possible causes of interruption and disconnection. Here, Reg explains the 'unknown' aspects of the network.

> R: It can be just bizarre things sometimes. It can be a lot of things. It can be antenna alignment signal, or the noise from other types of interference. It can be hardware things, lack of knowledge. Yep, quite a cocktail. There are some really odd things that have happened. Like there's a link that's gone down between me and someone else. We pulled it down and put it back and we're not getting a signal at both ends. So when I find out I'll let you know. So maybe this weekend we'll fix it.
>
> K: So how do you approach something like that?
>
> R: You just take things down and look at them. I don't know. We just look at the software side of it first and play around with it as much as we can and if that's not working it's probably hardware or antenna alignment. I guess it's like trying to get something to work that you have no experience with, I guess. Knowledge helps a lot. But now I have mine pretty down pat. I know what things can go wrong (Interview with Reg 06.03.07).

Reg cannot describe what is currently wrong with a connection between himself and another member or how he will fix it. It is a mystery on both fronts. Yet, strikingly, it is not cause for anxiety. The use of the term 'cocktail' suggests a colourful concoction of different elements that come together in a playful and leisurely context. Similarly, to 'play around with it as much as possible' signals that without a known problem there is no distinct or definite way of approaching it which makes Reg's lack of anxiety all the more intriguing. Similarly, Simon explains the 'mystery' of WiFi in relation to getting connected:

S: Everyone I've told is interested. But there is a step that goes from interested to doing stuff and that's a fairly big step. Purchasing the equipment and stepping into the unknown of whether you connect or not.

K: Stepping into the unknown? What makes up the unknown in this case?

S: You never know if you're going to be able to connect or not. The access point might be 100 metres away but there might be a big lead shield between you. Not that it's very likely but there're so many factors in it. We try and do as many tests at people's places as possible but some people just purchase the equipment and just go for it. In the case of Kerry, he's got the equipment and we went over to do a huge setup day and they just couldn't connect. All the stats said it was right, figures were fine and trees ok, but there was something blocking it. That's life. It's just that element of mystery in it. Because while we know how it works we really don't know how it works. Why is that dish talking to that dish over there and I'm able to send huge amounts of data? I guess it's all electro magnetic waves, but is it really? There are some places that you say it's definitely never going to connect. There're just too many trees, its just too far away, too many hills. And we'll get up there and point a dish and you get super signal and you go, 'Why?' There's no explanation for it but, 'Okay, we'll just accept it and use it'. In most cases you can work it out. You know there's a fair amount of line of sight to do it but it's never the ultimate case (Interview with Simon 03.03.07).

Simon's version of 'stepping into the unknown' evokes the concepts of openness and mutability that characterise other aspects of Air-Stream. When he says 'we know how it works' and 'we really don't know how it works', he reveals how he, and other members are comfortable with knowing *and* not knowing the network. Talking about the process of scaling in the use of architectural models, Yaneva calls this 'knowing it more and knowing it less at the same time' (2005:870).

These accounts give the impression of inherent instability, which could be read as threatening to the durability and longevity of the network. Yet, I have provided many examples of how members build them into the network that in turn draw attention to their resourceful and innovative abilities to deal with potential problems. They do not attempt to suppress, overcome or erase unstable actors but rather accommodate and work with them, thus making them as much a part of their toolbox as the modems, computers and wires that technically comprise the system. Importantly, members draw attention to these constant challenges and, in so doing, highlight their ability to ingeniously and resourcefully respond in diverse ways.

Family involvement

Considering many antennas are located on personal houses (or trees), and given many of the Air-Stream members are between the ages of eighteen and twenty five and living in the family home, another area of stability and instability concerns family. Parental approval is essential to ensure use of materials, tools, the roof and backyard as well as access to, and

payment of, electricity. However, what might seem a good idea to a twenty two year-old man may seem less so to the owners of the house, his parents and siblings. I did not encounter anyone whose family objected to their involvement in the group, but I noted regular instances of negotiation and intervention. As a result of membership being predominantly male, these examples emerge in relation to mothers, sisters, wives and girlfriends.

To keep his computer equipment cool, Reg purchased two powerful fans that ran at seven thousand rpm [revolutions per minute] and installed them up in the tree. They proved effective for this task but they also had another unexpected feature:

> When I was putting it together, the girls [his younger sisters] were saying, 'Are you serious, that's bloody well loud'. It turned into a pretty funny story. You know how you get those clear skies, those really quiet nights? Well, my mum's room is 100metres away from the tree and she said she could hear it (Interview with Reg 19.07.08).

The fans may work to keep the technology cool, however because they are located in a domestic setting, the fact they were 'bloody well loud', meant they had to work in a different way. To compensate, Reg installed a fan controller so he could adjust the speed, which addressed the problem in summer and in winter he simply turns it off. The fact that Reg's mother was unhappy about the noise of the fan shaped the design of his node. Getting power to an antenna ten metres up a tree also proved to be another issue that involved his mother.

> I get power from an electric fence box. We have a power connection outside for an electric fence box. It [the power cable] runs down the tree. It's strung across two trees and across the drive way. But it's pretty damn high, so you wouldn't even notice it if you were driving down the driveway. And then it goes down the side of the paddock about 80metres or something. Just as long as no one goes there and starts hitting the cable with a hammer or chews through it, it will be fine. But mum is worried about it, fires and stuff (Interview with Reg 06.03.07).

Despite the fact that this assembly of actors solves the problem, Reg's mother's unsurprising concern about bushfires again brought about adaptation in node design. His next iteration involved digging a trench under the paved driveway to the electric fence in which he laid two ethernet cables and a speaker wire. This undoubtedly involved further negotiation with his family. All the while his antenna leeched electricity from the domestic grid. His family's support in terms of resources and good humour, considering the interruptions his activities cause, illustrate how the network is firmly located in the existing domestic ecology. Here, Reg talks about his sister:

> I might be doing something and her friends will come over and say, 'What the hell is your brother doing up a tree?' Is he like Spiderman or something?' And I laugh. They pay me out [tease him] (Interview with Reg 06.03.07).

Feminist STS scholars have long drawn attention to the hidden role of women located behind the scenes of technological systems (Wacjman 1991, 2004; Cockburn and Ormrod 1994; Star 1995). Wajcman (2004) argues that, 'their absence is as telling as the presence of some other actors, and even a condition of that presence' (2004:41). Clearly Reg's mother's support is essential to the success of his antenna in the network and even his sister and her friends' jibes serve to fortify his innovative and experimental identity. Although women, and more broadly families, are pivotal to how the network is made, they are not visible in representations made by members. It is interesting to note that although Reg says he is making changes to accommodate his mother's concerns, he is also caught up in the relentless desire to make WiFi *better*. A few months later he upgraded again. This time he installed an uninterruptible power supply (UPS) in the box.

> That's another problem I solved. The power was going off a lot at home and we still have no idea why. But I put that box in to help the power up the tree. The power supply was dying because the power kept on going off and it was becoming very unreliable. It makes it more reliable. I thought about solar power for a while but it was too expensive. Could easily have done it though (Interview with Reg 06.03.07).

Saying he 'could easily have done it' clearly indicates that cost as opposed to skill or motivation inhibits him from experimenting with solar power. Further upgrades were being planned in July 2008, but have still not taken place. This time, in an effort to secure an even more 'reliable' connection to an antenna in the west of the city, he was working with members to build a tower on his mother's property that would extend even higher into the sky than what was currently possible with the tree. The regular use of the word 'reliable' initially appeared paradoxical in these contexts considering the inherent network instability. Yet, it reveals how members constantly negotiate the desire for stability and remain open to experimentation. During fieldwork, I heard many comments that reinforced the idea that WiFi is never finished:

> *Craig is sitting in the corner of the water tower [a new WiFi node site], wiring the new installation. He and Simon have been talking about all the new connections that will be possible once this new node is operational. He says he just wants to get everyone connected and that it's been his dream for years. He doesn't stop working on the antenna while he talks and I move closer so I can hear him properly. I ask him what happens when they all get connected. Simon answers first: 'We'll just keep upgrading, faster and faster' (Field notes 13.08.06).*

What is evident is that WiFi network is never achieved. It is suspended in the state of making. It can always be something else, something better, faster, stronger and more reliable. The relentless drive to improve the network also produces constant instability in the network.

Moving house, moving antennas

The short-term nature of rental property is another kind of challenge for Air-Stream members. Kerry and Jane had trouble with their rented property. They were penalised for damage to the roof, apparently caused by Kerry's many installations of different antennas in his attempts to get connected. As Jason's story at the November 2006 barbeque revealed, antennas that go 'down' do not always find their way back 'up' again when members move house. House moves, however, do not always threaten destabilisation to the network. Sometimes, a new site is more advantageous to the network than the old one. A member on the website described it as thus: 'Let's hope the new office is some sweet plum location!' (Accessed 10.02.08, Available at: http://www.air-stream.org.au/blog/ross/sayonara-apana).

Not everyone takes their antenna when they move which results in the installation of another antenna at the new site. The antenna at *Skye* for instance was left intact even when the members who lived there sold the house. Moreover, not all antennas are located on private houses. Some sites, such as a decommissioned water tower, the rooftop of a Government health building, office buildings, shopping centres, university buildings and local community centres come about as a result of members' personal and professional contacts. Although these sites provide network expansion possibilities, they come with their own instabilities. The node at *Skye* is a good example. Despite being technically stable, everything changed after the theft. Firstly, equipment was stolen and secondly, the owners got worried and rather than risk another attack on their property, they asked for the remaining equipment to be removed. Thus, the group lost equipment *and* a site. Another aspect related to instability of locations concerns negotiation. Members need to negotiate permission and access to the site, which necessitates significant research and advance preparation. Tim explains what happened at one particular site:

> It turns out that we got permission from the wrong person. The person that we got permission to put this up on the building wasn't actually the owner of the building at all. It was some old lady down the road. She was saying, 'No worries, you're a lovely young boy you can do whatever you want on my roof'. But she didn't realise we were referring to a completely different building. Yeah, we got a nasty letter the next day. I think it was a week later. 'What are you guys doing with all this stuff on our roof?' (Interview with Tim 08.03.07).

Although nodes that move can temporarily destabilise Air-Stream's network, new members and new locations also provide new opportunities. In view of this, instability plays an important role in the expansion of the network.

Volunteers, time and skills

> Because I've got so many other commitments I tend to squeeze it [Air-Stream activity] in instead of sleep most of the time (Interview with Tim 08.03.07).

Technology use is bound up in the rhythms of time in daily life. Studies of domestic media consumption have thoroughly demonstrated that concepts of 'family time' and 'personal time' are not the same as standard clock time. They take on their own temporal logics (Nippert-Eng 1996; Lally 2002). STS literatures give the impression that membership in a social group is ordered, organised and relatively simple to trace in science and engineering. There is a linear trajectory of skills development that can be traced according to materials and machines in specific places and is largely governed by time. Traweek's (1988) ethnography of high-energy physicists, for instance, has at its core a preoccupation with time. She writes of their 'everyday anxieties about the terrible loss of time' (1988:17).

> In the course of a career a physicist learns the insignificance of the past, the fear of having too little time in the present, and the anxiety about obsolescence in the face of a too rapid advancing future (ibid).

Time is clearly important to Tim but in ways more ambiguous than to Traweek's physicists. The use of 'squeeze' signals how he adapts and accommodates his wireless work around less flexible commitments in his life. The concept of volunteer time is further fragmented across the group. As illustrated at the barbeque in Chapter Four, the group is primarily made up of men aged between eighteen to twenty five and forty to fifty. Ron explained to me how this age gap is aligned to life stages (Field notes 09.11.06). When members get to a 'certain age', about twenty five, they get a girlfriend and 'disappear'. Ito (2006, 2008) notes a similar sort of disengagement in her volunteer anime translation groups. Similarly, the 'middle range' members get 'busy' with jobs or family life. They 'discover' or 'return' to Air-Stream when they have time again. While a shifting membership of this nature spells potential destabilisation of a highly ordered and hierarchical system, in the context of Air-Stream it means a diverse group share the financial, social and technical burden of the network. Ron who is forty five and Tim who is twenty three years old are good examples of these two types of members.

> Kat: So, were you on the roof last night?
>
> Tim: No I wasn't. I was there during the day.
>
> Ron: Our members spend a lot of time on roofs.
>
> T: I don't spend a lot of time, but I go up there regularly.
>
> R: The youngies, they don't have a lot of time on the weekend and they can never plan things.

T: We don't sleep. We think of doing something at 10 o'clock so we just do it.

R: Those with families and things have to organise things during the day. They [youngies] haven't got children to put to bed (laughs) (Interview with Tim and Ron 02.03.06).

Younger members are more likely to do emergency, evening or weekend work and invest more of their disposable income while those with family commitments invest infrastructure and materials in the network. Older members need more time to plan their involvement and have periods when they cannot do wireless work. As a result large installation events that require lots of volunteers are not organised around long weekends, Christmas or Easter breaks. Likewise, some of the younger members are not available during university exam times or when music festivals come to Adelaide. The heterogeneous and disordered nature of the group means that someone is always available to do wireless work. This also means that an unstable membership actually contributes to the stability of the group.

Another aspect of stability and instability concerns what volunteers actually do in the group. Ron regularly reminds people in meetings, on the website and in emails that the network is only as good as what members put into it.

Peter, talking about new installation plans, says it might only be two key sites and some upgrades but 'it'll make a big impact on the city'. It will 'open up the south and double the network'. There are excited murmurs in the group. Ron interrupts, curbing the enthusiasm a little. 'Yes, but it only gets done if people do it'. 'It's only as good as the members who make it and sometimes people get busy'. He talks about how sometimes people just think the committee will do it but the committee is made up of people with busy lives. He says, its 'up to all of us to get it up and running' (Field notes 28.06.06).

Without members' skills, bodies, houses, money, time and financial investments as well as the often overlooked, yet essential support of their families, the network would not exist. The technical cannot be separated from social or natural actors. Craig and Peter provide illustrative examples of the range of investments considered vital to the success of the Air-Stream network:

Craig starts to fit the antennas together. There is a new pre-packaged antenna and one made of house guttering. As I watch, Peter joins me and I ask where these devices came from. Without looking up, Craig says 'Hoist' at the same time Peter says 'the benefactor'. I look to both of them to explain. Craig points to a logo on discarded plastic and says the company who makes this stuff is Hoist. 'As in Hills hoist?' He says, 'Yes, they make lots of stuff'. Then I look to Peter and ask him who the benefactor is. He points to Craig who I can see is smiling as he looks down on his work. I ask him how much he has donated to the group. He looks up briefly, smiling and looks down at the antenna again before saying: 'Five to ten thousand, I guess' (Field notes 13.08.06).

At twenty, Craig is one of the youngest in the group and its most significant financial supporter. Single, living at home and working during the day in a local laundry means he also has more flexible time than other older members with families. He is quite happy to be on-call if something breaks. Peter, forty, is one of the older members and married with two sons, views his participation to the group in a different way.

> *Ron is drilling into the walls to fit the antenna brackets, Craig and Simon are wiring the new antennas and Reg is precariously hanging out of a window fitting an antenna. Peter and I have been running errands as general 'dogsbodies'. We stop to watch the others and he says he wants to be part of it but he doesn't have the 'technology speciality', but supports them in other ways and points to our lunch wrappers. An hour earlier we both went to buy lunch for everyone. He says he doesn't have the disposable income like Craig who is a single young guy with his first job and is 'really passionate' about it and his commitment is to it 'every waking moment'. Peter admits he doesn't have that passion but he is more interested in people and being involved. He also has a car from work and they supply him with free fuel, even on weekends. 'So that is my contribution'. He laughs, 'I carry around gear' (Field notes 13.08.06).*

Craig and Peter were both voted on to the committee at the 2007 AGM in recognition of their contributions to the network. Although differently configured, both investments are equally valued. During my fieldwork, Peter became Air-Stream Secretary and merchandise manager and Craig became responsible for Network Planning and Administration. These examples illustrate how varying levels of personal time and investment do not splinter the group, but instead render it cohesive. Furthermore, these roles are not static. As an illustrative example, I describe how I was encouraged to participate in the group.

> *At the end of the night, I talk with Peter about the extra work he and Craig have to do on an antenna and ask if I can join them. He says yes and writes down my mobile number and email in his book. Ron sees him do this and Peter looks up. He says, 'Kat is going to come and take photos for us'. I'm surprised. We hadn't talked about me taking on any particular role, especially a role so clearly defined. Ron says, 'She's a volunteer you know. She can be a general dogsbody too'. Peter laughs at this. 'But I'm the dogsbody, that's my job' (Field notes 26.07.06).*

My initial reaction was one of relief and concern. I was relieved that I was being involved but anxious about being given a role, especially that of the photographer. Aware of Pink (2000) who became a photographer as a way into the bullfighting world, I was wary of committing to such a firm and defined role. How would I see how members themselves took and used photos if I was doing it? I discovered however, that I had been 'tagged'.

> *Explaining how committee members could better leverage other members involvement in the group, Ron says that people generally don't put up their hands, so you have to 'notice a thread' posted by a person on the website and say, 'Ross, I'd like your help'. Then you 'tag them' to help out on a certain area. (Field notes 07.01.07)*

Being tagged is an invitation to participate and contribute. It recognises a person's interest or skill and leverages it in the context of the group. It is a pivotal step in becoming an active member in Air-Stream, however, as with other aspects of the group, it is not a permanent or inflexible role. Importantly, I was not considered the photographer. Several people also had cameras on the day and we pooled photos for posting on the website. As per Ron's comments, Peter had interpreted my research blog, ubiquitous notepad and camera, not unsurprisingly, as an interest in taking photos and documenting events and used it to attach me to the group.

Tagging in this sense bears little similarity to physical tags in books and more with social classification systems like *Delicious* or *Tumblr*[27] that classify and link content together but do not limit meaning to one place. These digital tags are multiply constitutive and infinitely flexible. Weinberger calls this 'the new digital disorder' whereby tags no longer have to abide by the 'silent limitations' of single possibilities (2007:7). He explains, 'In the past, everything had its one place - the physical world demanded it - but now everything has its places: multiple categories, multiple shelves. This is the miscellany of modern life' (ibid).

For Air-Stream, tagging signals a different way of enrolling people in certain activities than Henderson's (1999) concept of conscription. Although both account for how visual representations organise people, they do so in very different ways. To conscript is to compel someone or something into service. In the armed forces, for example, a recruit is not asked to comply; there is little choice. In engineering, Henderson describes how the 'conscriptive quality of these visual representations is so strong that participants find it difficult to communicate about the design without them' (1999:74). In Air-Stream, tagging serves to bring people together to get work done, however, individuals retain choice and flexibility to take on other jobs and interpret them as they wish. Members can also be multiply tagged. Much like the clusters that regularly formed in Air-Stream meetings and in the quadrangle around the barbeque, being tagged created different networks of possibility.

Building interruption into the system – the 'other broadband'

Air-Stream members give the impression of being familiar with interruption. Anything that goes wrong can be fixed, thus defusing the threat to destabilise the network. They are fundamental to innovation and experimentation. This is echoed in the structure of the network itself.

[27] See http:www//.delicious.com and http://www.tumblr.com

Air-Stream is a networked infrastructure not dissimilar to the internet itself in that it operates by connecting individual nodes to create networks that enable people to transmit *and* receive data signals. As a result, there is no one central hub of the system. Using these dedicated channels, 'backbone' nodes transmit data full speed to and from these key points and distribute it between their attached clients. Each can support up to thirty simultaneous connections to smaller 'client nodes' and Dan's was one of these. The central point to glean from this technical description is that the Air-Stream network is deliberately constructed to accommodate variability. It views constant unpredictability as strength. Redundancy is *built into* the network. Ron explains how he tells new people that:

> [You] can actually set up your own telecommunications network and they go, 'Oooh', so we get the next level of member who wants to set up access points and have them, what we call, back boned to other access point and that's the redundancy system we were talking about. So if you have an access point and people connect to that then if you can provide two points and preferably three points of connection of other networks then if that network fails it can go through that (Interview with Ron 16.01.06).

Ron's use of the term 'telecommunications network' signals a distinctive aspect of Air-Stream's use of WiFi. It makes clear members' interest in connecting to one another instead of connecting to the internet. Air-Stream's distinctive position is made clear in Fig. 24, a poster produced for and distributed at the group's annual Open Day held at a local primary school for the purpose of demonstrating what the group actually does to members of the public. At a time when broadband has become synonymous with the internet, images like this unsettle conventional understandings of technical infrastructure largely constructed through engagement with commercial ISPs.

Volunteer community wireless groups around the world differ according to technical legalities, landscape nuances and, as I will briefly discuss, their vision of connectivity and view on the internet shapes their infrastructure and in turn their visual culture (Fig. 25). *Ile Sans Fil*[28], a community wireless network in Montreal, Canada, has set up a completely different network to Air-Stream. They believe the internet should be free and encourage people to connect with each other through it. Technically, *Ile Sans Fil* do this by installing 'hotspots', in a similar style to commercial providers, in local cafes, parks and residential houses. This group is less concerned with networked infrastructure and more with a series of distributed points through which people can access the internet for free. They directly pitch themselves in competition with local ISPs. In 2005 I attended the World Summit of Free

[28] I have randomly chosen this group but I could have selected any number of community wireless organisations that operate in a similar way – such as Consume in London (http://www.consume.org), NYCWireless in New York (http://www.nycwireless.org), CUwin in Champagne Urbana (http://www.cuwin.net) or Portland Telco in Oregon (http://www.portlandtelco.net).

Information Infrastructures conference (WSFII 2005). Benoit Gregoire of *Ile Sans Fil* told the audience that at that time Montreal had the highest free WiFi coverage in the world with fifty-eight hotspots and ten thousand users, managed by thirty-five community member volunteers (Field notes 01.10.05). He boasted how the success of the community group had reduced the cost of commercial internet access from seven to three US dollars per hour. Couched in commercial framework, this group measures itself in terms of economically disadvantaging competition by destroying the ISP consumer base. Fundamentally, *Ile Sans Fil* and ISPs both deliver the internet via a central pipe to an individual user. People connect to the internet first and then to others. However, if the exchange through which the internet is piped crashes, then connection lost, and people become disconnected to one another, until it is fixed. The hub of the system is central to connectivity.

Air-Stream's 'other broadband' is different. It uses a distributed network that supports interdependent relationships between many clients (Fig. 8). There is no one central hub in this system, or any limit to how far it can expand. Instead each node is 'backboned' into the network via multiple dedicated paths or pipes. Using these dedicated channels backbone antennas transmit data full speed to and from attached clients. This pattern is repeated with the next closest antenna and so forth, which means a person in the south east of the city can connect to someone else in the north-west. With this infrastructure Air-Stream connect people to one another, not just to the internet. In replicating the structure of the internet, Air-Stream create alternative ways to join people together. However, rather then connecting nodes all over the world, Air-Stream nodes are deeply embedded in the local landscape; on member's houses, backyard sheds, factories and office buildings. This is how Air-Stream members make a local version of the internet.

Because breakdown, mistakes and malfunctions are built into the Air-Stream system, they are not considered interruptive in the traditional sense of the word. Interruptions do not *happen to* the Air-Stream system, they are *part of* the system. They do not cause failure but rather provide opportunities for members to learn about the technology and adapt the system. The study of failure is important in STS (Ackrich 1992; Law and Callon 1992; Latour 1996). In his analysis of Aramis, Latour (1996) links its failure to the fact that no one cared enough about it to guarantee its survival. For Latour, a technology needs to be able to connect to existing networks, which enable it to become stable and therefore durable. This reflects the dedication and range of financial, emotional and material investments required to keep the Air-Stream network operative. In other words, it needs to be constantly loved.

> Yet in spite of its fragility, its sensitivity, how have we treated it? Like an uncomplicated development project that could unfold in successive phases from the drawing boards to a metro system that would run with 14.000 passengers an hour in the south Paris region every day: twenty-four hours a day. Here is our mistake, one we all made, the only one we made. You had a hypersensitive project, and you treated it as if you could get it through under its own steam. You believed in the autonomy of technology (1996:292).

The success and durability of the Air-Stream network lies in two aspects of the network: its constant care and sustained commitment of a small group of vigilant users and the distributed nature of its technological design. Because the network is never considered completed or finished, it is therefore constantly monitored. This means that if something breaks, a member of the group immediately races to site to address the issue. The distributed network of nodes means that if one breaks down or is stolen, only smaller nodes, like Dan's, are disconnected. For everyone else, data is re-routed away from this point. This enables Air-Stream's network to continue to work in the presence of absent or dysfunctional points and means that a crashed node in the north of the network has little, if no, impact on the south of the network. Constant interruptions to the system, coupled with the constant monitoring by its users, therefore serves to strengthen it.

Although this helps to understand why Dan was the only one disconnected, it does not explain the role of Air-Stream's visual representations, such as the node map, in this unstable system. What value are representations of a network that constantly changes? What becomes evident in Air-Stream is that unlike science or engineering inscriptions, members do not expect their visual representations to point to a fixed reality. In fact, no single inscription is expected to bear sole responsibility for representing the network. Instead, the map, like the many others enrolled in the network, operates as part of Air-Stream's visual culture. An illustrative example of this is provided by my experience at Software Freedom Day, a public OSS event held at a local community centre. I helped set up the Air-Stream display table in one of the classrooms. Piles of A4 colour network maps, a range of hand-made antennas, open laptops running live demo's of the network and other printed 'how-to' documentation lined the tables. A large poster version of the network map was stuck to the door and photos from installations were projected onto a wall. There were also building sessions and online trials.

> *Ron, Simon, Tim, Peter, Dave and Craig are all wearing black Air-Stream t-shirts with different logos, jeans or shorts. Kerry, Janet, Kevin and Peter, are also members of the local Linux group, so they are in bright orange Software Freedom Day t-shirts and are busy setting up displays in a nearby room. Jane saved me one, which I am wearing even though I am sitting in the Air-Stream room. These classroom walls do little to keep members in the one spot though. They regularly move between rooms, helping to demo antennas and talking in the hall and around the barbie in the carpark. Visitors to the event are mostly men, who arrive alone,*

with a girlfriend or wife and are immediately greeted at the door by Ron or Peter who, depending on the new person's level of knowledge direct them to various points around the room. In addition to the display of photos, antennas and maps, Simon and Craig are working on laptops, preparing online demo's, and nearby Reg, with his younger brother, is putting together a wireless box to go into a tree near his parent's house (Field notes 17.09.06).

Although WiFi is technically invisible and intangible, in this room and at this time, a diverse array of visual representations made it clearly visible and knowable. And, it did so in multiple co-located ways. This scene reinforces what I have argued in the last chapter about the disordered design of Air-Stream's visual culture. The visual culture of the group provides stable points of attachment that serve to attract and recruit new members and echoes what has been written about inscriptions in STS. Yet paradoxically, many different versions of the network were simultaneously present and members and visitors alike gathered them in varying assemblies. This further illustrates Tim's comments about the range of visual presentations deliberately made to encourage new people to 'visually attach' to the group. Moreover, at this event, these assemblies of representations were tailored to the visitor's knowledge, interest, eagerness of their partner to get away and the aroma of the outside barbeque. It suggests what Law describes as 'an object that wasn't fixed, an object that moved and slipped between different practices in different sites' (2004:79).

However, the fact that Air-Stream representations co-exist in overlapping and contradictory ways signals something beyond simple slippage. Looking even closer at one of these representations reveals further variable complexity. During my year with the group, five versions of Air-Stream's node map were distributed at meetings, at events such as Software Freedom Day and on the website (Figs. 26, 27). Each represents a version of Air-Stream's network at a particular time, which illustrates how it constantly changes. Looking closer still, we see how instability is inscribed *into* each one. As introduced in Chapter Two, the map is a two-dimensional geographic representation of Adelaide over which is inscribed a series of labeled dots and lines. The dots indicate the location of nodes and the lines between are connections. The colour of the lines indicates the status of connections; working connections are black, those in need of upgrading are pink and ones currently offline but soon to be fixed are blue. In June 2007, further variance was introduced with new colours representing the type of WiFi connections. Upgraded connections became visible as well. In addition to illustrating the network coverage across Adelaide, the map operates as a working tool, used by Air-Stream to make plans. Clearly, it does not represent a single reality of the network at any one time. It represents, to borrow from Mol (2002), the multiple network. In view of this, the map is better understood in relation to other contingent and messy assemblies of the Air-Stream network.

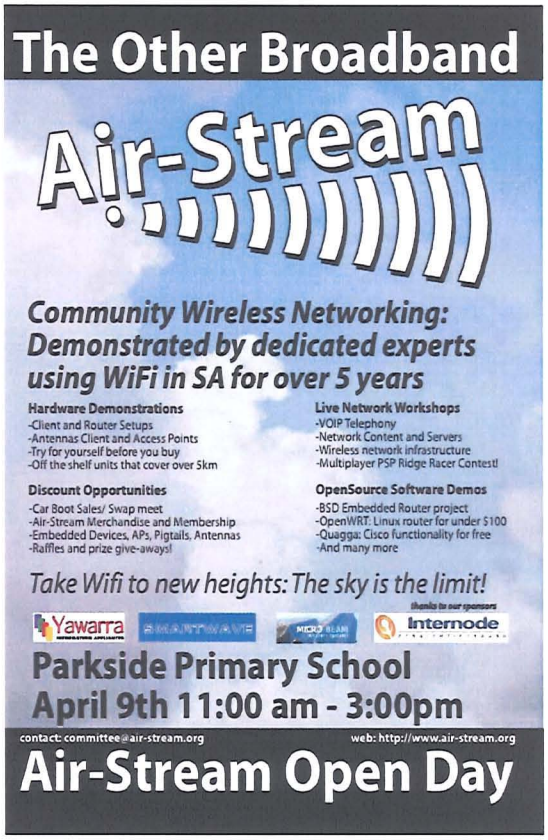


Fig. 24. Air-Stream Open Day poster – 'The Other Broadband'

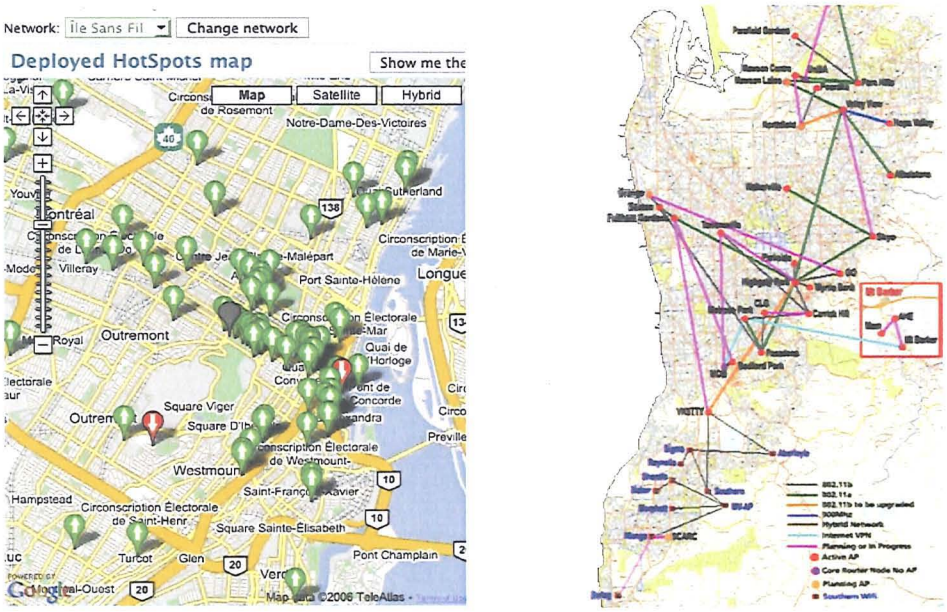


Fig. 25. *Ile Sans Fil* network map of individual 'hotspots' in Montreal (Accessed 10.06.07. Available at: http://montrealtechwatch.com) and the Air-Stream network of connected distributed nodes on the website (Distributed at an Air-Stream meeting 16.09.07).

Fig. 26. An updated network node map being distributed at an Air-Stream meeting (28.02.07).

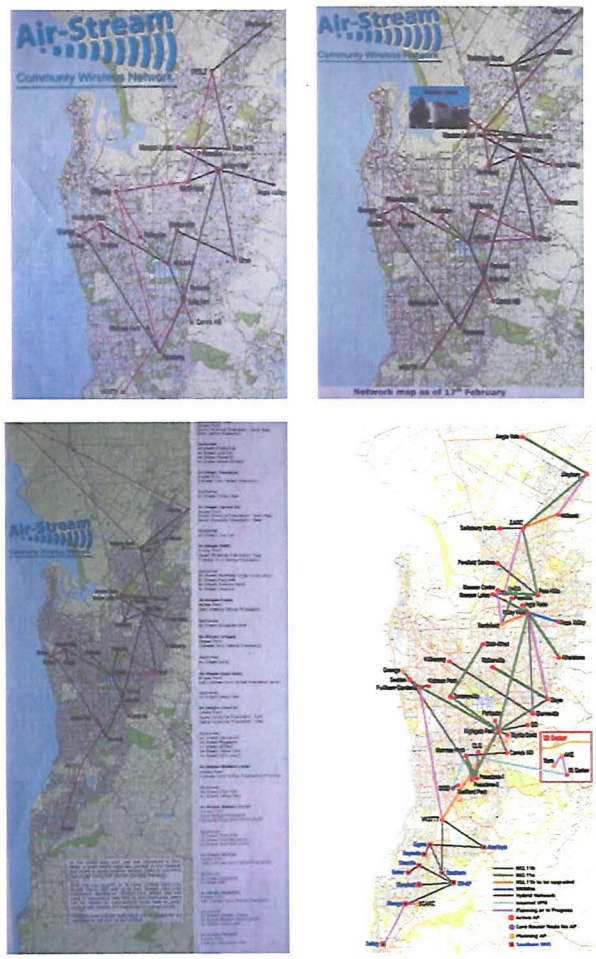


Fig. 27. A selection of Air-Stream's network node maps
(Sept 2006, Feb 2007, June 2007, Feb 2008).

Conclusion

Air-Stream members delight in the unpredictability of their WiFi network. They view the interruptions as challenges that do not threaten their understanding and use of the technology, but rather serve to create an adventure of achieving a connection. In the process of constantly making and re-making WiFi, Air-Stream members have the opportunity to display their ingenuity in overcoming diverse impediments. Just as Singleton illustrated that 'ongoing instability characterises and lubricates the continuation of the CSP' (1998:102), I have shown how constant instability shapes and strengthens the network. Moreover, echoing Kleif and Faulkner (2003) I have shown how fun and playful aspects of the infrastructure are important in attending to the constant instability of the network. Reg's tree node solution is a key example. Placing a node in a tree is not a problem free solution. In many ways it manifests new and unexplored territory. The tree sways in the wind, there is increased possibility of fire from the electricity cables and rain and the box is more susceptible to bugs and birds. Yet, rather than irritants, unstable actors are folded into the 'unknown', 'mystery' and challenge of making WiFi and provide opportunities for new forms of expression and imagining the technology.

In view of this, what is clear is that *getting connected* is the aim of the group, more so than connection itself. As a result, this chapter provides a twist on Green and Harvey's 'imperative to connect' in which they asked 'what *disconnections* are entailed in connecting' (1999:12 emphasis in original). Conversely, I found that disconnections, in the form of constant instability that interrupts the network, provide the means for connection in Air-Stream. Without the constant threat of disconnection, the group would not be as strong as it is and its innovative spirit would not be as vigorous or demanding. Drawing attention to the close association between men and the wireless network also serves to highlight the lack of women in the group. Although mothers, sisters, girlfriends and wives are integral to the success of the network, their involvement and presence is largely invisible, hidden behind the scenes.

This chapter has shown how the ability to deal with the unknown is central to the group. As Singleton (1998) has argued, lab workers need 'good' and 'bad' samples in order to do their job, so too do Air-Stream members. In view of this, it is possible to suggest that instability makes members better technology designers. I have argued that Air-Stream members make WiFi not *in spite* of interruption, but *because* of it. Moreover, it is fundamental to how the group innovates.

Chapter Six.

Mods, middlework and making-do

In this chapter I examine how Air-Stream members make their work-in-progress, or *middlework*, visible in the public domain and the consequences this has on how the network is shaped. Although middlework is recognised and valued within STS for its role in the construction of knowledge, it is hidden from public view. Specifically, I trace how Air-Stream members 'mod' [modify] a range of materials in the process of making WiFi, and how this approach acknowledges and, moreover, celebrates the virtues of a technology that constantly breaks and requires mending. To better understand the nature of this aspect of their visual culture, I introduce the concept of 'making-do': a unique Australian approach to technological innovation and adaptation borne of intractable places and conditions. Then, drawing on Miller and Slater's (2002) study of Trinidadian's who displayed an 'affinity' to the internet, I suggest 'making-do' accounts for why Air-Stream men appear to 'take to' WiFi.

Making *middlework* public

At a monthly meeting, Ron asked Peter and Craig to update the group on an antenna they had built and installed over the weekend on a domestic roof in the northern suburbs of Adelaide. Using the digital projector in the school computer room, photos were projected on the screen behind the teacher's desk (Fig. 28).

> *Peter and Craig stay in their seats while the rest of the group talk over the top of a series of photos on the wall screened by Simon, who has connected his laptop to the projector. We see photos of the two men clutching bulging shopping bags in a local hardware shop, working with tools in a suburban backyard and squatting in the butted edges of iron sheeting on the roof of a house. Peter explains how they had to 'mod' [modify] their initial plans. The first 'mod' came about when they were faced with 'stuff-all' selection of tripod masts at the shop so decided to make their own. They bought a nine-foot pole, some smaller lengths of piping, nuts and bolts. They flattened the tubing for strength but found the bolts were too small, so they returned to the shop for new ones. Later, they encountered the extreme incline of the roof and more 'mods' were needed to ensure the mast was strong enough to withstand the wind and local birdlife, yet could be brought down for repair and upgrades. But it wasn't easy. Peter says: 'We kept sliding down, everything kept sliding down the gutter'. Despite this he thinks they did a good job because, 'it'll still be there if a bloody hurricane comes through'. They also had extra pressure getting it done within a pre-agreed time to avoid inconveniencing the homeowner. But, because of the 'mods' they had to leave before they could troubleshoot an 'untrustworthy cable', which means they have to return next weekend. Ron congratulates the men saying he 'loves' their photos because 'they show how it is done from scratch', 'they show ordinary blokes doing stuff' and 'he likes the story they tell' (Field notes 26.07.06).*

This field note captures the group's interest in work that happens in the middle, between raw materials and the finished node – the 'middlework'. If members were only interested in a finished node, a very different story might have unfolded. Perhaps then Peter and Craig might have waited until the node was actually working. Remarkably, the very thing the node

does, that it is built to do, is not the focus of these representations. Instead, Peter and Craig's visual story draws attention to the 'mods' involved in making WiFi. Mods are modifications that come about when things do not quite fit as a result of changing conditions or available materials. For Air-Stream members, modding involves adjusting pre-purposed plans in line with the nuances of materials, the location, personal skills and time restraints. Mods reveal an ability to adapt to changing circumstances and unexpected happenings. As Ron points out, Peter and Craig are 'ordinary blokes doing stuff', which highlights the contrast of a highly sophisticated and complex digital technology in the hands of male backyard technologists. Further still, recognition and reward, in the form of Ron's comments, springs not from smooth and exact results but from encounters with a range of contingent assemblies, tangents and variations. As a result, this field note reveals the value attributed to resourceful adaptability and ingenious practical knowledge and in doing so, it renders visible, and public, the invisible process of making WiFi. Focusing on members' interest in middlework suggests that conventional parameters of success and failure, or even start and finish, are inadequate for understanding how members assess their activities and determine what is valuable or not.

In the last chapter, I argued that Air-Stream make WiFi not *in spite* of instability, but *because* of it. In this chapter, I draw attention to where this instability, in the form of middlework, is located. Scientists and engineers traditionally do much of their work away from the public eye. Although experimenting with materials and ideas is axiomatic in STS in these contexts, what I call middlework always takes place behind the scenes. Latour and Woolgar have shown how inscriptions have a 'direct relationship to 'the original substance'' from where they originate but the 'intervening material activity and all aspects of what is often a prolonged and costly process are bracketed off' (1979:51). A study by Delamont and Atkinson (2001) on the 'socialisation' of science students demonstrates how the role of mess is considered an essential but intrinsically secret part of scientific knowledge. They illustrate the 'reality shock' experienced by students as they move from the controlled and predictable world of academia to the frustrating 'real' world of science. To become good at science Delamont and Atkinson (2001) show how students are taught to produce inscriptions that completely discount and dispense with messy middlework. They call this 'textual enculturation', whereby the mistakes, vagaries and uncertainties are removed and replaced by successes and final results (2001:103). Stripping away mess results in precise singular accounts of the world, deliberately sought after by scientists to form layers for their cascading knowledge structures. By contrast, being a 'newbie' in Air-Stream is very much about learning to embrace and celebrate both mess and middlework.

The fact that middlework takes place behind the scenes in more traditional science and technology arenas means that there is always tension between private instability and public stability. Upon attending a conference that deliberately provided an opportunity to voice medical practice uncertainties about the cervical screening programme (CSP), Singleton notes 'ambivalent hostility toward voicing the indeterminacy and instabilities' (1998:99). Even in circumstances where unpredictability and uncertainty are recognised as essential to the durability of the system, they are resolutely hidden behind the scenes. Singleton goes so far as to suggest 'the exposure of instability could threaten the existence of CSP and the laboratory' (1998:99). Although instability is central to the efficacy of the CSP programme, it transforms into a threat should it ever come under public scrutiny. This is even more extreme than Henderson's engineers who were 'embarrassed' that she saw 'the messiness of the process, the sketches in the margins, the further corrections to the drawings as the machines got built' (1999:205). Specifically, what upset them was the fact she was seeing 'the contrast between actual practice and the myth of technological development, which is supposed to occur in smooth outgrowth from clear scientific formula applied to human needs' (ibid). This was not the case for Air-Stream members who routinely made their messy middlework visible to each other and to me and for whom meetings, the website and other open public events, were precisely the right forums in which to voice instabilities and indeterminacy.

Air-Stream members' informal way of revealing middlework is therefore striking. In this chapter I am particularly interested in exploring how middlework functions for Air-Stream. I will now describe in detail how a node gets built, installed and connected to the network in order to explore what motivates members to engage in this practice and correspondingly what emerges from making middlework public. In particular, I follow one member's attempt to get connected to the network.

Fig. 28. Peter and Craig (seated) 'update' the group using photos projected on a screen (26.07.06).

Making the network, not just consuming it

> I have recently put up an AP [access point or antenna] for testing purposes. If anyone is interested, especially those in the Athelstone/ Newton/ Rostreveor/ Campbelltown/ Highbury Area, please have a stumble[29]. It's a high power setup with omni, the SSID is Air-Stream-Athelstone-Test. Doing some wardriving[30] myself it seems to be fairly easy to pick up 'this side' of St Ignatius, in the upper area of Rostrevor, in the upper Athelstone area. Maximum distance I picked it up with just a mag-mount antenna on the car was 1.6kms. I couldn't pick it up driving along George Road because the landscape falls into a bit of a valley there plus there are massive trees in St Ignatius grounds. Anyway, if you can see the Campbelltown soccer club building from your roof there is a good chance you can stumble my AP. I remember from nodedb [node database] there were a few people in my area interested/waiting for activity. Please come out of the wood works and contact me if you are interested in connecting a node, want help with a stumble or have a suggestion for another backbone link.
>
> Dave's website post (Posted 01.11.06, Accessed 02.11.06. Available at: http://www.air-stream.org.au/node/854)

Dave announced plans on the Air-Stream website to install an antenna on his parent's backyard shed, ten kilometres north east of Adelaide's city centre and called for 'a helping hand or two'. After responding to his post, he emailed me:

> *Just to let you know that Sunday is going ahead. I am combining the AP [access point or antenna] raising with a BBQ with cooking starting at 11am (Field notes 11.11.06).*

Dave's webpost firmly communicates his plans and begins to establish his antenna in the network and in the Adelaide suburbs and surrounding areas and uses both to enrol volunteers, which, in the context of representations in science, means he is 'recruiting allies' (Latour and Woolgar 1979). Implicit in the webpost is an intimate knowledge of topographical nuances of the landscape and cartographic directions, such as what the soccer club building looks like and where key streets are located. In this instance, WiFi is not 'everywhere' but rather can be 'picked up' in particular places in suburban Adelaide. Moreover, Dave is clearly not at all sure what will happen. On one hand he writes about 'securing' equipment and 'picking up' signals in key areas and on the other, he mentions 'chance', 'testing' and 'looking forward', which implies there is little that is definite or fixed about what he is about to do.

To gain a sense of what Dave is planning to do, it helps to understand how he got involved in the group. At twenty-two years old, Dave is a small compact man with dark hair and a quiet considered manner. Recently graduated with a degree in engineering and computer systems, he had been working on contract for a variety of Adelaide companies but was

[29] Stumbling is also known as site surveying. It involves scanning for the wireless signals around a specific location and results in a series of textural and graphic representations of 'wireless noise'. It is a visual inscription device that is explored in detail in Chapter Seven.
[30] Wardriving is similar to stumbling but it involves driving around in search of wireless signals.

looking for full time work in the area of industrial automation. I first met Dave at the June 2006 monthly meeting and regularly saw him at meetings and events over the year, such as the Software Freedom Day and the Air-Stream LAN party (ASLAN). In addition to ethnographic interviews conducted during these and other interactions we also met specifically for a recorded two-hour interview. I initially thought Dave was a 'newbie' like me, because on several occasions I introduced him to other members, however I discovered he knew about the group from the very beginning. He attended the group's first Open Day in 2000 and kept in touch with Tim and other 'original members' via the website and IRC [Internet Relay Chat - a collaborative instant message software]. He attended meetings in 2004 and joined 'officially' at the end of 2005. He explains:

> I wasn't really that well known. I was in the background a little bit. I used to go on the IRC channel and used to know a few people from there. I kept updated with all their activities. I used to actually go around, the term is wardriving. I would connect up to the network whilst sitting in my car and sort of browse around and have a look. But I wasn't really involved in such a capacity as going along and meeting people and doing installs and things that I have been doing the past year (Interview with Dave 20.02.07).

The open culture of the group enabled Dave to participate in Air-Stream from the outside. However, he did not feel 'involved' until he started 'doing installs and things' which signals the importance of contribution. As I have been arguing throughout, being an Air-Stream member is not about using a technology, but about making and customising it without the limitations of bandwidth, regulations and cost imposed by ISPs (Fig. 29). Members become part of a community, not just a consumer of a service. They are expected to develop the network. This is clearly not a one-way relationship, but rather speaks of a multi-directional engagement with the technology. In line with this, Dave is not only raising an antenna at his house in order to connect to the network, he is also contributing to the expansion of Air-Stream's coverage across the city, which in turn helps build in redundancy should anything go wrong.

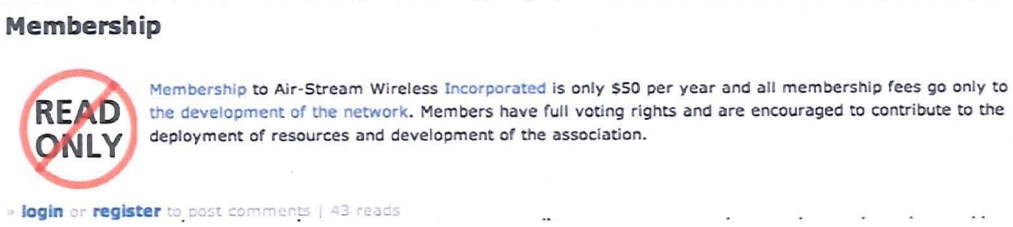


Fig. 29. A description of Air-Stream membership
(Accessed 10.06.06, Available at: http://www.air-stream.org.au/membership).

In Chapters Four and Five, I argued that Air-Stream's network reveals multiple and fluid characteristics. I showed how fluid technologies (de Laet and Mol's 2000) and multiple systems (Mol 2002) are firmly embedded in complex heterogeneous networks, yet they also operate independently. For instance, although many versions of diseases co-exist and overlap, an individual can still be diagnosed with atherosclerosis. Similarly, the water pump is fluidly distributed around the country in lots of small villages but it retains the ability to work independently. These objects are simultaneously multiple and singular. The Air-Stream network is different. The network is comprised of multiple distributed nodes, however, no one person can make the network and a single node does not work on its own. It is made up of lots of smaller actors that gather together to form the larger network. Furthers still, it relies upon individual participation and contribution interconnected in a collective collaborative system. This is why Dave's node needs to connect to other points in the network in order to gain strength and reliability. Every new antenna has the dual purpose of reinforcing the reliability of the service and providing more opportunities for new people to get connected to the network.

Barbeques, sheds, families and other contingencies

> *It is midday when I finally spot the house in a neat row of single storey brick bungalows set in neat garden edged lawns. Wheeling my bike along a paved driveway I see two men standing around a smoky barbeque in front of an open and very full backyard shed. They spot me and the older man yells over his shoulder, 'Dave, one of your friends is here'. Looking past the two men and into the shed, I see Dave sitting on a garden chair with his laptop. He is surrounded by detritus of suburbia: bikes, garden benches, old paint tins, hammers and shovels, bits of wood, fishing rods, lawn mowers, hoses, insect repellent, garden poisons, camping equipment and ladders. I also see two women on a swinging sun seat at the edge of the house. They warmly welcome me, asking if I want something to drink. I hear yelling inside the house and Dave's sister explains 'the boys are playing games inside'. I ask if they are from Air-Stream. She shakes her head. It's Dave's younger brother and one of his friends also here to help (Field notes 13.11.06).*

This field note presents a strikingly different vision of new technology development. Instead of negotiating access to a sterile laboratory or corporate office filled with carefully catalogued materials, expensive machinery and suitably attired technicians, I have been invited to a sprawling single storey brick bungalow, surrounded by neatly mowed yet drought ridden lawn, a shed and small vegetable patch on a very typical Sunday afternoon; the whine of a lawn mower, a cat, the scorching sun, a smoking barbeque and extended family and friends. As discussed in Chapter Five, Air-Stream's network is made up of a series of interconnected nodes located on private houses, commercial factories and

supermarkets across the city. Depending on the location, members' homes provide crucial sites for the network because they are free and easily accessible should something go wrong. As a result domestic infrastructures are pivotal in making volunteer community WiFi. Unlike Kerry and Jane however, Dave will not have to negotiate with a disgruntled landlord should something happen to the roof and unlike Jason, he will not have to pack it up, if and when, he moves away from home. He does, however, need parental permission and support to build and install a node. In this case, he has successfully negotiated the roof of the backyard shed.

> *Dave introduces me to his brother in-law and his dad, who wearing an apron and flourishing a pair of tongs says, 'We're cooking skippy[31]'. Looking at the hotplate I see quite a lot of 'skippy [kangaroo]', but he points out that in addition to kangaroo fillets, there are the usual chops, 'snags [sausages] and onions. I lean my bike against the fence, peer around the corner of the house looking around for the node, the reason why I am at the barbie, but instead I see a large ping-pong table, covered in a floral plastic tablecloth and set with twelve places. I feel relief that I am not late and I start to worry that I should have told them I am a vegetarian (Field notes 13.11.06).*

As described in Chapter Four, barbeques are regular features of Air-Stream events such as summer meetings in the school quadrangle, at large installation events and at the annual Open Day where antenna shoot-outs and product demonstrations are set up next to 'snag' packed hotplates. (Images like Fig. 30, signal the normative intertwining of WiFi and barbeques in the group). Although I initially found the combination of wireless technology and barbequed meat surprising, as I have argued earlier, the Air-Stream barbeque says less about the actual food on offer and more about the socialising it makes possible. What surprised me, in this instance therefore, was an emphasis on the barbeque. The set table, special meat and the presence of the extended family seemed at odds with previous experiences at Air-Stream events. As a result, I felt uncomfortable that I had not pre-warned Dave of my being vegetarian. Up till then I not thought my eating habits were particularly relevant to my study about WiFi. I had not expected the barbeque to play such a pivotal role because I viewed it as a vehicle *for* wireless work and not as an integral actor *in* the network. Making this shift reveals how the barbeque serves to embed WiFi in the domestic footprint.

For Air-Stream members, the barbeque is a celebration of the middlework of making and installing a new node. It represents Dave's family's approval and support and given his invite, it is also a method for enrolling and persuading volunteers to donate time on a sunny afternoon (Fig. 31). Barbeques suit WiFi for even more reasons. Signalled by the fact it is

[31] 'Skippy' is the name of a kangaroo, the central character in a popular 1970s Australian children's TV program. Although 'Roo' has been eaten in central Australia for many years, it is a relatively new source of meat in suburban Australia.

most often conducted outside, they are public events. Unlike hackers who are 'not joiners' (Wark 2004) and tend to be engaged in their pursuit in the isolated privacy of their bedrooms or offices, Australia WiFi is not a private or individual activity. Air-Stream's WiFi relies upon sociality, which is highlighted by the arrival of Simon.

> *Dave's dad yells out that 'skippy' is ready and brings a tray of sizzling meat to table. It is shortly accompanied by a range of salads: a yellow curry rice salad, green salad, half boiled eggs with curry powder, tomato sauce and a bag of white bread. I take a seat and ask Dave who else is coming. He shrugs. He thinks Simon and maybe others but 'it depends who is awake'. It is agreed that lunch should start and if any one else comes 'they can join in'. The ping-pong table quickly fills with Dave, his friend and younger brother, his sister, her husband, his parents and me. It turns out, unlike at Air-Stream meeting barbie's, there is plenty for me to eat so barely anyone notices I do not eat 'skippy'. It is after one o'clock when Simon casually walks around the side of the house and sits down at the table. Dave greets him warmly and passes him a plate of 'skippy' (Field notes 13.11.06).*

Simon, twenty, studies IT at TAFE [technical college] and does volunteer technical support for a local primary school. Although I offered Dave my 'dogsbody' assistance for carrying and holding things, Dave appears especially relieved to see Simon arrive at the barbeque. Simon has less money to invest in the network than Craig, but he invests his time, volunteering to help with the installation of new antennas. He is especially experienced, given he started 'playing around' with computers when he was twelve and has been involved with Air-Stream's WiFi since 2002 (Interview 03.03.07).

Even before any wireless work has started, I have drawn attention to a range of contingencies. Dave needed space to build and a location to install and as a result, relied upon approval and support from his parents and extended family. He also needed help from experienced, as well as inexperienced, volunteers to raise it. Good weather is also necessary. Although some of these elements can be planned in advance, the way they came together is largely unknown, indicated in Dave's comments - 'it depends on who is awake' (Field notes 13.11.06). The reality of raising an antenna involves a range of messy contingencies and necessitates an accommodating and responsive approach to a dynamic unfolding series of events.

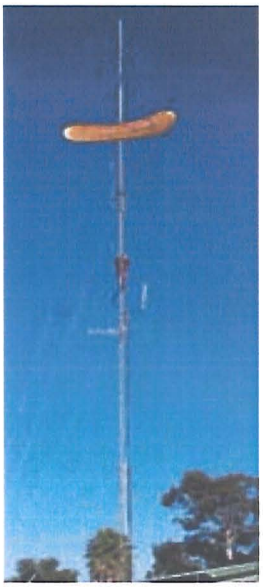


Fig. 30. A retouched photo of a 'snag' skewered on a WiFi mast published on the Air-Stream website. (Accessed 12.10.06, Available at: http://www.air-stream.org.au/northfield)

Fig. 31. Cooking 'skippy' on the barbie before raising an antenna (13.11.06).

Bricolage - conversing with materials 'at hand'

> *Directly behind the ping-pong table at the side of the house is the backyard. Dave crouches on a rectangle of lawn between the vegie [vegetable] patch and shed at the other. A dry water feature, a 'whiz bin' [recycling bin], an empty birdbath and colourful pot plants line the corrugated iron fence while CDs in the fruit trees twist and glitter in an attempt to keep hungry birds at bay. With a silicon gun in one hand Dave peers close, touches and occasionally stands back to look at a steel tubular pole that lies suspended between a canvas camping stool and a wooden garden chair. A coil of blue cable lies on the grass at one end and a wireless dish connected to an omni antenna and a white box is U-bolted to the pole at the other. A house brick keeps the dish on an angle. Various tools, sticky tape and sun-screen lie scattered nearby (Field notes 13.11.06).*

Dave's actions reflect those of the 'bricoleur' as described by Levi Strauss (1962) and later by Turkle (1995) (Fig. 32). In his head for the last five years, in planning for eight months, at a total cost of eight hundred dollars [GBP£380] 'so far' and countless hours of preparation it was for Dave a long awaited afternoon. Yet, Dave's movements suggest an openness and responsiveness to the developing node. Comparing different computer programming styles, Turkle writes of the stark difference between the 'hard' canonical structured system characterised by ordered and organised planning and a more informal 'soft' approach that stems from an affinity with the materials (1995:51). She argues that it is an important and under examined approach to problem solving and design:

> By analogy, problem-solvers do not proceed by abstraction but by thinking through problems using the materials at hand. By analogy, problem-solvers who do not proceed from top-down design but by arranging and rearranging a set of well-known materials can be said to be practicing bricolage. They tend to try one thing, step back, reconsider, and try another. For planners, mistakes are steps in the wrong direction; bricoleurs navigate through mid course corrections. Bricoleurs approach problem-solving by entering into a relationship with their work materials that has more the flavour of a conversation than a monologue. In the context of programming, the bricoleur's work is marked by a desire to play with lines of computer code, to move them around almost as though they were material things – notes on a score, elements of a collage, words on a page (1995:51-52).

Turkle (1995) writes of people who do not simply organise materials, they engage with them. They do not just hover about on the surface but rather get inside a task and respond to materials. As a result, a thick description of engagement *with* materials, not just *of* materials permeates Turkle's (1995) writing. A central tenet of this type of interaction, and evident in Dave's actions, is the idea of a conversation with materials. Looking closely at Dave's setup reveals a mix of old, new, modified and what Turkle (1995) terms materials 'at hand'. The pole came from Mildura, a large country town on the border of South Australia, about six hours drive from Adelaide. Dave explains he 'heard about a pole' at his aunt's property, which signals his extended family's awareness of, and interest in, his project and the expanding network of actors involved in bringing disparate materials together.

Dave was not sure if it was possible but his 'resourceful' aunt contacted the local shipping company, which turned out to be a man in a shed who apparently did not look at all surprised by the request. He was used to people turning up with ten sheep and wanting them sent somewhere, so a pole 'was nothing'. It cost AUS$20 and was sent to Port Adelaide, about twenty kilometres west of his house, so Dave borrowed his Dad's ute[32] *to pick it up. (Field notes 13.11.06)*

Dave's family are clearly enrolled in helping Dave 'mod' his node. He also 'found' the box that houses his computer equipment in a kitchen cupboard - an old biscuit tin. Because it will be located on top of the aluminium shed, and exposed to the full force of the sun, the wind and local wildlife a number of mods have been necessary. For instance, to counter the effects of the sun, Dave carefully painted the entire box with several coats of light coloured hard-wearing and reflective house paint that he found in the shed. He is also using a 5.1ghz [gigahertz] antenna built by a backyard technologist in Tasmania and sent to Air-Stream as a 'tester'. It has yet to be tested, so this is, as Simon says 'an elaborate test'. 'Finding' and 'hearing' about things is in keeping with the concept of being in conversation with materials. It is indicative of being open to your environment enough to consider alternative materials that may not perfectly match initial plans. Although Dave purchased several brand new items such as cabling and U-bolts that attach the box to the pole, the majority of materials were gathered together from his local environment and personal connections.

Looking closely at the contents of the biscuit box reveals intricate attention to detail and meticulous order (Fig. 33). The motherboards are painstakingly mounted to provide access and ventilation. An ethernet cable is neatly coiled and tied. Perfectly drilled and filed holes in the top of the box for ventilation have been insect-proofed with neat squares of flyscreen. Two other holes firmly hold the large U-bolt with which it will be secured to the pole. The wireless pigtail has been inserted into another neatly drilled hole and sealed into place with clear silicon putty. The combination of ad hoc materials with sophisticated technical knowledge and improvised methods gives Dave's antenna a unique character. Every point in Air-Stream's network is hand-made, either entirely or at least to some degree, using a range of improvised methods, personal skills and available materials. In Chapter Four, I argued that the visual culture of Air-Stream is not a fluid because it does not gently flow from point to point, gradually shifting in shape accordingly to different conditions and users (de Laet and Mol 2000). Rather, visual representations of the Air-Stream network are made differently from the beginning and changes are more distinct and abrupt, and often catalysed by the unknown actors. The portal, as discussed in Chapter Four, demonstrated this idea and

[32] A ute is an utility vehicle with an open tray back that can pretty much carry anything.

a close reading of Dave's node erection provides further evidence. Every node is 'modded' on site and therefore shaped to match the nuances and texture of the site.

Dave is building the node to withstand harsh weather conditions, as well as local fauna and flora. It is being built to last, but as I will show next, it is also designed to change

> *Dave gets a tape measure and with Simon on the roof they measure the distances they will need for the guy wires - about five metres. The pole will be bolted to a bracket in the centre of the shed roof and these wires will secure it at four pre-drilled and cemented hooks in the aluminium sheeting. Measuring five metres across the yard, Dave has me stand at one end on the curling wire. He uses the combination of me and the yard to measure consecutive lengths. While we do this Simon tells us about another node which needed five sets of guy wires set three metres apart. This makes it 'very secure'. This is good and simultaneously not good because they 'need to do some changes', but before they can do this they 'need to work out how to get to it'. Dave jokes that they need a 'cherrypicker'. Simon asks Dave if he has tested his remote switch (Field notes 13.11.06).*

This interaction signals Air-Stream members' awareness of the instability of the network and its role in shaping the design of new nodes. Installing a remote switch is an important feature of Dave's antenna because it means Dave will not have to climb up the antenna to the box or take the entire setup down in order to reboot it when there are problems. As outlined in Chapter Five, intermittent connectivity is part of the network, therefore it holds that Dave builds a way of dealing with inherent instability into his node.

Fig. 32. Dave works on his antenna in the backyard (13.11.06).

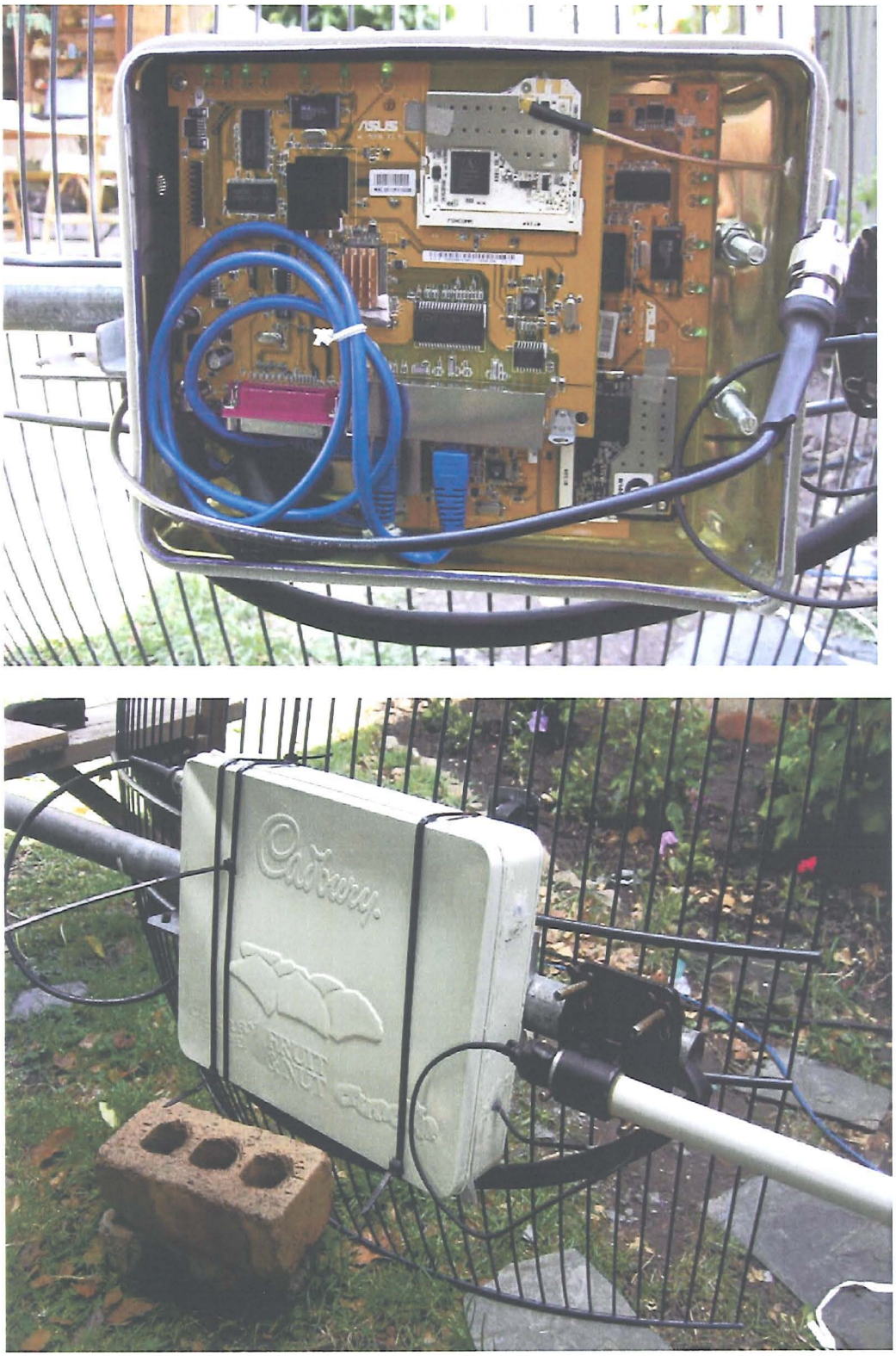


Fig. 33. Inside and outside the biscuit tin node box (13.11.06).

Fig. 34. Building an antenna is a collaborative activity (13.11.06).

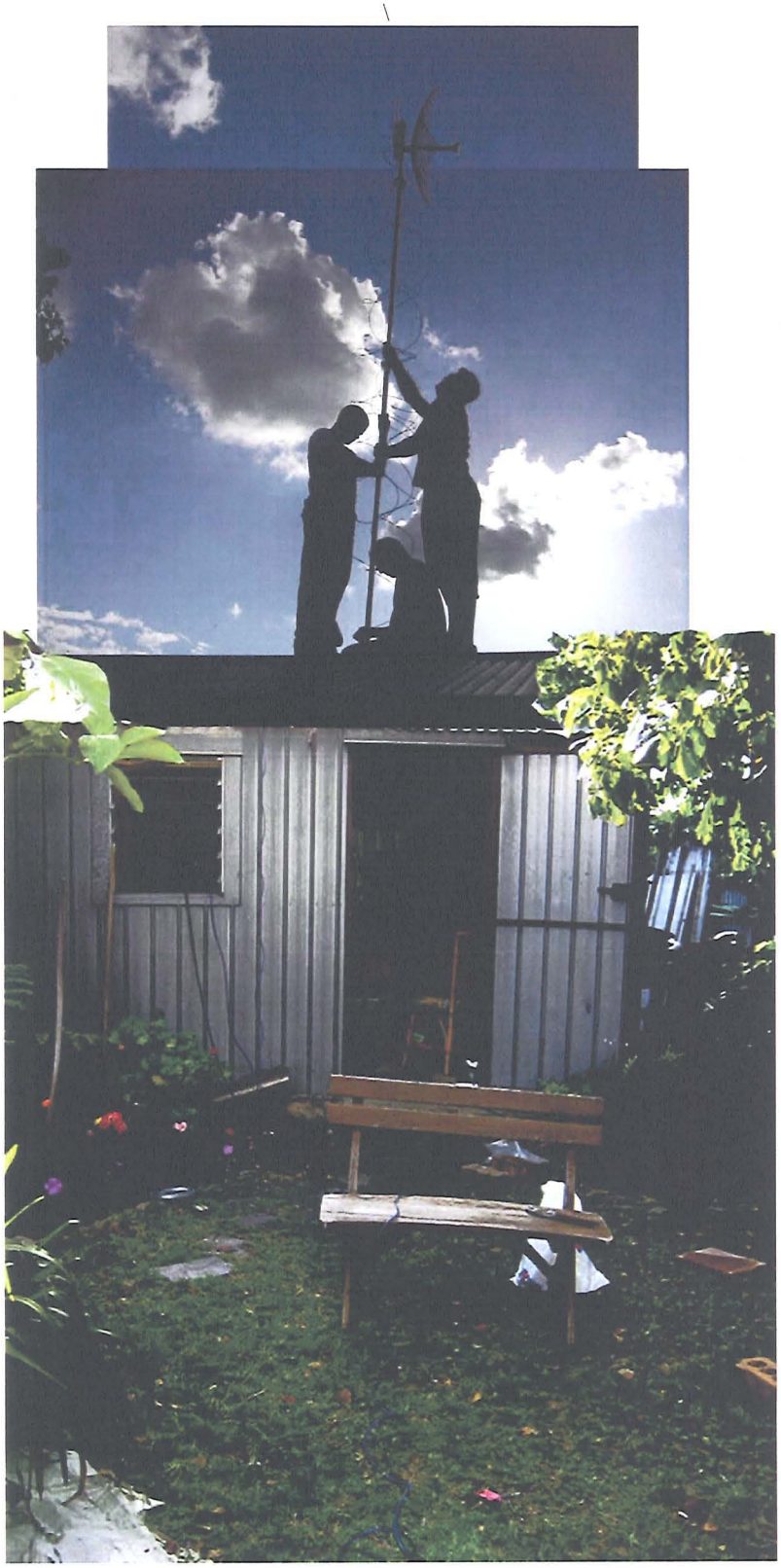


Fig. 35. Raising the antenna on Dave's backyard shed (Personal image 13.11.06).

The thrill of making things fit

> *We hold different ends of the pole and slide it through the garden chair that it has been balancing on. Simon then takes the lead and hoists it into a vertical position, leaning it against the edge of the shed. Dave plugs in the electricity and the ethernet cables into the shed and does preliminary tests to see if it is working. At this point, more people arrive to participate in the raising of the antenna. Dave's dad, his brother and friend Josh come into the yard to help. Dave's father holds the ladder while Josh and Simon climb onto the roof and Dave and I help hoist the antenna up over the edge of the shed. Together they hold it in place in the centre seam of the roof. Dave gets the guy wires and pulls one to the edge of the roof where he has earlier drilled in hooks and with his dad's help he secures the wires to the four points on the roof. When required, I pass various tools that lie strewn on the grass and garden furniture. (Field notes 13.11.06)*

This field note reinforces what I have argued earlier about the collaborative nature of Air-Stream's network. Building Dave's antenna involved Simon, Dave and I. Raising it involved a much larger contingent. Dave, Simon, Dave's brother and his friend Josh, his father and mother, Dave's sister and brother-in-law, Simon and myself as well as Craig on the phone were all involved in varying degrees (Figs. 34, 35).

> *Dave brings out some cold drinks and offers sunscreen to combat the fierce late afternoon sun. Even my camera is having trouble adjusting to the glare from the reflection on the galvanised shed roof. After the steel pole is secured to the top of the shed with the guy wires Simon returns to his laptop on the pingpong table [table tennis games table]. He talks on his mobile to Craig who is at his home scanning for Dave's new node. They are talking about the fact that Craig cannot 'see' Dave. Dave is on his laptop in the shed. He keeps rebooting the software and scanning for Craig's node. Dave is worried that maybe the antenna does not work after all. (Field notes 13.11.06)*

It was past six o'clock in the evening and I had spent over six hours with Dave in his backyard. Although the antenna was now secured in place on top of the backyard shed, it was still not part of the network because it had not been 'seen' by another node. Without a connection, an antenna is just an antenna, an individual point, isolated from the network. Nothing happened for a further half an hour, when suddenly Dave burst out of the shed and grabbed my shoulder shaking it in excitement, saying 'He sees me, he sees me'. At this point, Dave's antenna became a node.

At the following monthly meeting I saw Dave talking with Simon and Craig in the quadrangle of the school.

> *Dave asks if I have heard what happened and bursts into a story about problems he has had with the node since the installation. He tells me he had to replace the dish because it did not work. This meant he had to take down the entire antenna; the pole, box, dish and the four guy wires. This job was undertaken late at night, when it was 'very windy' and only Craig was available to assist. That night, the dish was replaced, the box was reset and the entire node was re-raised on the roof of the shed. Considering it took five of us the better part of four hours in broad daylight to do the same job, it is an impressive achievement. It is now 'almost perfect', except one guy wire got tangled when they re-installed it and it is caught around the*

pole which means there is not enough length to secure it to the corner of the shed roof. He says, 'it's got to come down again'. (Field notes 29.11.06)

In addition to recounting the story at the meeting, Dave posted a candid account of his many attempts to get connected on the website (Fig. 36). Strikingly, he did not revise the event or re-inscribe in any way the narrative in an attempt to hide the mistakes or awkward aspects of the afternoon that resulted in less than perfect results. Instead, he drew attention to non-standard materials and improvised techniques employed in his setup. His photo captions include: 'Turnbuckle ready to be tightened, but not for the last time', 'The professional waterproof box' and 'Mmmm guy wire fun' (see Fig. 36). With a combination of honesty, humour and pride, he reveals several mods. These do not highlight the unprofessional nature of the process but rather draw attention to his inventiveness, originality and ability to deal with unexpected challenges.

In his analysis of hill-walking, Vergunst (2008) writes about how the experience of walking is not about successfully reaching the destination but about the dramatic scenery, unexpected weather conditions and all the other challenges that arise along the way.

> The success and media coverage of the book and film *Touching the Void* (Simpson 1998) taps into a certain fascination with when things go wrong, telling the story of a physically and socially catastrophic fall into a glacier. Richard Storer's popular book *The Joy of Hillwalking* similarly devotes a chapter to 'hillwalking accidents'. As he writes, 'the longer the fall, the more excruciating the pain, the greater spillage of blood, the more salivating relished the tale' (Storer 2004:117). All these biographical narratives convey an intensity of experience, when something 'really happened' on the journey (2008:105, emphasis in original).

Dave's dramatic tales of the wind and the darkness that contributed to the challenge of taking the antenna down make for a good story. In Vergunst's (2008) words, it conveys 'an intensity of experience'. In accounting for why he posted such a candid account of his installation on the website, Dave explains:

> Probably the main reason for documenting things like that and reading those pictures would be to show someone who's not quite sure. They want to do a similar thing or they want to copy it. You show them for example the inside of the box I did, like the two boards sitting in there. That's an idea that could be shown to someone else. They might have an idea of 'Ok I want to use two of these, but how can I do it?' So, 'Here I've done it before' and 'Have a look' (Interview with Dave 21.02.07).

Dave represents all the problems, solutions, tangents and dead ends he encountered on the way to making his node. In this context, the messier and more complicated the story, the better. Dave's comments reflect the idea that by representing in intricate detail the process of how he made his antenna and node, he is helping others learn and build on his ideas. Making

middlework public serves to educate and illuminate others who are and are not members of the group. In showing a way, he is providing a description, an account from his perspective and experience. It is not meant to be definitive but rather serves to depict or sketch one approach. It also serves to promote and broaden Air-Stream's network.

A distinction needs to be made between what Dave calls 'showing others' and what is colloquially known as *showing off* and goes some way of explaining his deliberate and repetitive use of 'professional' in his webpost. Thomson argues, relative to backyard technologies, that Australian's have good 'bullshit antennas' (2007:94). This means that they are sensitive to sounding too cocky, too high and mighty or showing off. To avoid this Dave adopts a self-depreciating tone to avoid presenting himself as too serious or his practice as deterministic or dominating. The Air-Stream group eschews a triumphal point of expertise. Instead members promulgate a flattened topography of knowledge in which anyone can contribute. In describing his experience, Dave's account reinforces the idea that there is no one way of doing something, there are always many ways of doing things. Importantly, Dave does not impose *the way* of making WiFi, but rather shares *a way* of making it that co-exists with other versions on the website. This echoes aspects of Peter and Craig's earlier representations. The fact they did not stand up, but rather sat with everyone else indicates a sharing of results rather than of presenting them.

Martin has argued that laboratory inscriptions 'point away from the complex messiness of the experimental work that preceded them towards a simple, immutable form' (1994:164). In contrast, Air-Stream representations do the opposite. They do not 'point away' from the messy reality of practice, but rather enfold them into the visual representations they produce. Interestingly, Dave never uses the word 'works'. It is not about what works and what does not. He talks instead about 'ideas that could be shown' and how he shares his discoveries with others, not just members but openly on the public website. He is describing one way of making WiFi, not the only way. As I have shown in Chapter Four, the concept of 'working' in Air-Stream is multiple and fluid and Dave's antenna reinforces this. What this means is that every node in the network is different. Each has its own story. Much like the distinctiveness of a signature, Dave's personality is indisputably stamped on it.

What emerges in this chapter is a visual culture of the group that expands to encompass multiple descriptions of how WiFi is made. Interestingly, it does not matter if these descriptions are of mistakes or tangents. From the initial invite through to the candid narration of the afternoon, Dave gave no indication that revealing, or of me seeing and documenting, his middlework was in any way problematic or cause for anxiety.

I initially characterised Dave as shy and reserved in the group. The practice of exposing messy middlework played an important role in helping him establish not only a place for his node in the network but also a place for himself. Middlework enabled him to develop a reputation as a WiFi maker. Things that did not fit together in his backyard revealed his ability to deal with big problems. The story he told at the meeting and in his candid webpost helped to create a role for him in the network despite the fact his node kept crashing and did not, at this time, actually extend or contribute to the reliability of the network. This contradictory relationship is possible because of the value the group places on making WiFi over a finished or perfect node. As a result, I argue this account can be directly related to his nomination and subsequent election as Secretary in Air-Stream's committee at the 2007 AGM.

As a result, Dave's representations of middlework mark a striking difference to Latour and Woolgar's (1979) concept of an inscription. Instead of tidying up loose ends and narrowing or entirely closing down alternatives by cementing ideas in place, Air-Stream members assemble and constantly reassemble shifting, malleable and complex materials, places and roles in the everyday making of WiFi. At no point can one single or definitive version of the network be fixed or known, rather, it is only temporarily stabilised in order to allow members to flexibly respond to the relentless uncertainty of their local context. As a result, they demonstrate a much closer relationship to mess and the texture of practice. In doing so they exhibit an intimate relationship to their technology. It is not about long distance control but intimate, close up control.

Dave produced a number of visual representations in the process of planning his node and in representing his complex middlework. Moreover, the antenna, the array of tools involved, volunteers, Dave's parents' shed and the barbeque are visible instantiations of the process of making WiFi. There were also a number of absences. It took an unnerving length of time for Dave's antenna to be 'seen' by Craig's node. Then, when a connection was achieved it was not fixed or definite. The node was re-installed twice more and still had to come down again. As per the nature of the technology and the larger actor-network in which the node resides as outlined in detail in Chapter Five, Dave's connection will never be entirely solid or stable. The fact that it was deliberately built for such incidents further attests to the co-location of a series of actors that are both present and absent. Indeed Dave's account suggests a number of absences and presences and as a result shares much with Law and Singleton (2005) concept of 'fire-like objects'.

What marks a striking contrast to Law and Singleton's (2005) fire concept however, is that in the context of Air-Stream, these presences and absences co-exist. You might not be able to have charcoal and flame, but you can be simultaneously connected and unconnected at the same time. Dave's node may have been working but the tangled guy wire necessitated the lowering of the antenna once more. What emerges instead is the presence of many descriptions of WiFi, in which things that work hold just as much importance as things that do not. The former enables the network to achieve reliability, the latter ensures the network continues to develop and expand. The fact that Dave continues to change, fix and shape the node reveals how middlework in Air-Stream cannot be erased because it is never closed. It is constant. The conversation with materials never ends.

Modding and mods – Australian middlework?

Air-Stream conversations, webposts, meetings and interviews were regularly punctuated with stories of making, breaking and fixing things. The following definitions emerged in interviews:

> It's about finding the limits and potentials of the items. Some of these things I've got here I've modified to exceed what their specifications were when it was shipped. I guess you are trying to find something more by modifying it because it doesn't quite fit what you are doing or you are trying to do something slightly better, so you try and bring your model up to speed with what you believe you need to do (Interview with Simon 02.03.07).

> Make it do something that it wasn't designed to do (Interview with Tim 07.03.07).

> It's mostly making stuff work (...) It's building things. It's part of the culture of taking things that weren't quite made to do what you want them to do and make them do something slightly different. It's the whole adaptive approach. (...) 'Oh I wonder if I can just...', 'Oh, oh look at that isn't that interesting'. 'I'll make use of that'. So the original manufacturer wanted to do this really limited thing with it and people go, 'Hey you can do other cool stuff as well' (Interview with Kerry 22.02.07).

Mods involve finding or buying objects and re-purposing them to make them work faster, reach further or do something entirely unexpected. For Air-Stream members, mods lie at the heart of experimental encounters and demonstrate an aptitude to make things fit together. Ben's reflections also point to the ways in which a large community of WiFi makers might value mods.

> A mod is fixing, modifying something that you use it for a better purpose. Basically getting an antenna that's free off someone's roof and converting it to use it for wireless or 2.4gig which would cost you about $200 [GBP£95] for an antenna that you can get for about fifty bucks if you were to buy it off someone. If someone was to sell you a modded antenna, you'd probably buy it for about fifty bucks, if it was a hundred or so to buy new. So they do hold their value especially after you modify them (Interview with Ben 01.03.07).

In many ways, it is not surprising Air-Stream members embrace this practice given their predilection for resisting the constrictions of other boundaries such as the places in which work takes place, times in which it is done, the materials used, and the existing capability of the technology. What Ben is saying is that modded objects do not lose their value. In fact, if you get the original material, such as a free antenna from someone's roof, then they gain in value. This example suggests that mods are not incommensurate to high technology but rather have their own measurable value. Another key feature of mods is the absence of a finished point, as I have argued in previous chapters, there exists a never ending but constantly present desire to render the network reliable. Mods remain in relentless suspension of being made. This is not an accident or result of sloppy work but is a deliberate feature. The fact they remain unfinished leaves them open to further change.

Search

Shortcut Menu

- Access Point Map
- Access Policy
- Getting Involved
- Technical Information
- Network Content
- The Committee
- ASLan - For gaming fun!
- Member Discounts
- Latest Posts

Getting Involved

- What is a Community Wireless Network (CWN)
- What is a Wireless Internet Service Provider (WISP)
- What is an Open Access Network (OAN)
- About Us
- Joining the Community
- Meeting Information
- Australian Community Wireless Organisations
- ACMA licensing requirements
- Air-Stream Access Points
  - Network Node Classification
  - Network Planning Sand Box
  - Southern WiFi Network
  - Air-Stream-Athelstone
  - Air-Stream-Angle-Vale
  - Air-Stream-APANA
  - Air-Stream-Carrick-Hill
  - Air-Stream-CLG
  - Air-Stream-EARC
  - Air-Stream-Hillbank
  - Air-Stream-Hope-Valley
  - Air-Stream-Uleybury
  - Air-Stream-VK5TTY
  - Go West 2008
- Copyright & use of this site
- Do you use wireless (802.11*) equipment?
- Presentations
- The visual culture that surrounds community wireless networks
- Digital Divide Project
- How can organisations

Home » Getting Involved » Air-Stream Access Points

Air-Stream-Athelstone

Access Points Projects

Another new site has been setup at Athelstone and is now operational.

Athelstone uses two Mitsubishi R100 units.
One is configured for an accesspoint with a high powered radio and a 9dbi Collinear Omni in Vertical Polarisation. The other R100 unit configured as a backbone to Valley-View in 802.11a.

Thankyou to the volunteers who gave much of their time to assist in getting this access point fully operational. The site is managed by Shadey and additional backbones are being considered for the future.

Pictures from the first install

The professional power supply

The professional waterproof box

Bribe..I mean feed..the workers

and business get involved?
- Air-Stream Members on the front cover.
- Business Opportunities
- Our Community Supporters

Navigation

- Image Galleries
- Forums
- Tracker
- User Blogs
- Polls
- News Aggregator

User login

Username:

Password:

Log in

Who's online

There are currently *1 user* and *10 guests* online.

Online users

Quarion

Recent comments

- Tunnel broker issues
  adhoc
  04/07/2008 - 11:01
- Casual Perminate IP allocation
  robert
  04/03/2008 - 13:35
- I would only like to connect
  tigerwolf
  04/03/2008 - 11:15
- The Mawson Centre Experiment
  robert
  04/02/2008 - 19:14
- Best bit was lunch...
  Didz
  04/01/2008 - 11:36
- IPv6
  sfraser
  03/31/2008 - 18:19
- Pics
  remyzero
  03/31/2008 - 10:19
- Congratulations to our new Air Stream amateurs
  cougar
  03/30/2008 - 17:43
- I heard Skye was stumbled
  Duncanj
  03/29/2008 - 18:05
- Good Stuff
  Didz
  03/28/2008 - 23:28

Starting to come together

mmmmm guy wire fun

New forum topics

- Wanted to trade: Diamond Digital R100 for Meraki Mini
- Accessing Mawson Lakes
- For Sale - Bargain MWGAP 54G Wireless Access Points
- Gear to sell Dish's PC's and cable's, make an offer
- Wireless clean out

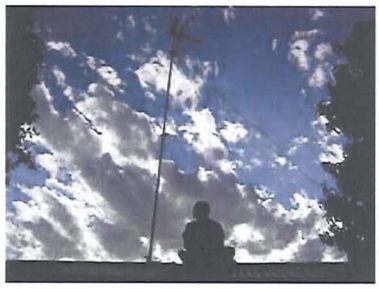
more

WIA Affiliate Member

Air-Stream Wireless Incorporated is proudly an affiliated member of the Wireless Institute of Australia

More guy wire fun. The bottom of the mast is attached with a U-bolt to a hills tin roof mount, which is bolted through top rafters of the shed

Turnbuckle ready to be tightened, but not for the last time..



After all that.. "No Scan Results" on 802.11a. Luckily the omni antenna could be used as a temporary Air-Stream connection.

Install Part 2

It turned out that the modified (for 5.8 GHz) grid antenna was useless, I guess we should have tested it properly before putting it into production. Anyway the grid was replaced with a brand new hills 5-5.8 GHz grid, unfortunately there are no pictures from that "install" because it was done at 11pm at night by two people. In any case it would be a bit hard to take photos when both hands and head are being used to hold up a mast in gully winds. Special thanks to DrGeforce for coming out on that crazy night.

Install Part 3

However that was not to be the last part of the story. In the hastiness and darkness of that night a guy wire somehow got snagged around the top of the guy plate. It would not come loose without pulling the whole thing down again, even though there was now a stable 5.8 GHz wireless connection, the mast guying needed to be fixed. Thanks to more volunteers this was taken care of on another occasion, in about 30 minutes. A second set of guy wires is now attached and the rig is solid. The most recent picture can be seen on the top of this page.

‹ Southern WiFi Network up Air-Stream-Angle-Vale ›

Printer-friendly version Login to post comments

Fig. 36. Dave's webpost published on the Air-Stream website (Accessed 10.01.07. Available at: http://www.air-stream.org.au/athelstone).

'Making-do' - An Australian approach to inventiveness

> (..) the bush convention – all that making-do, that genius for improvisation of the great army of the deprived in the Australian Bush (Clark 1978, *cited in* Moyal 1987:92).
>
> A central theme of Australian architecture is this making-do or vigorous adaptation of old ideas to new settings (MacMahon and Dupain 2001:9).
>
> Here we make do with language, as we make do with low rainfall and thin soil and bits of wire (Watson 2008:198).

Because WiFi constantly breaks and requires mending using a combination of improvised methods and available materials, I propose it fits with the idea and the practice of 'making-do', a distinctly Australian approach to technological innovation and adaptation borne of intractable places and conditions. Making-do emerges from the peculiarities of harsh bush conditions, economic struggles and limited materials of Australia's colonial past. It is a survival technique that fuses local knowledge, ready to hand materials and hands-on skill. It is about resourcefulness and innovation using improvised methods. Although white settlers brought tools, building materials and established ways of working to Australia, they had not planned on a fundamental difference: the landscape and ecosystem. Rarely did technology produced in other countries simply *work* in Australia. Imported tools inevitably required adaptation due to a combination of sharp differences in topography, magnified scale of use and drastic shortage of labour, which gave rise to the practice of making-do with what you had. Thomson explains:

> With transport slow and distances from cities great, an ability to solve any number of small engineering or manufacturing problems was necessary for a farmer's survival. A broken plough could not be repaired by a quick phone call or a part trucked up from the city overnight. The problem had to be fixed through ingenuity and resourcefulness. The aptitude for nifty solutions with a length of fencing wire, a hammer and a piece of 4" x 2" timber is strongly ingrained and widely felt to be some sort of national competitive advantage (Thomson 2002:8).

South Australia, in particular, became renown for agricultural innovations specifically made to address unique local problems. In the early nineteenth century farmers had few problems growing bumper crops in the 'wheat belt', but they had trouble planting and harvesting them. In 1843 local farmers, John Ridley and John Bull, invented the Stripper-Harvester that mechanised the harvesting and threshing of wheat to the point of replacing the work of fourteen men. By 1860 it was widely adopted throughout the country. Another problem for farmers were Mallee stumps that regularly broke plough bolts shipped in from Britain. The Mallee is a particular species of eucalyptus tree found in South Australia renown for its knotty, stubborn root system.

Frustrated with waiting for replacements that were no more suitable than the broken ones in his possession, a local South Australian farmer, Ron Smith, invented the Stump Jump plough which literally jumped over obstacles and 'revolutionised global farming practices by allowing the cultivation of newly cleared land before all the stumps and rocks were removed' (Soker 1993:24). These examples, although not revolutionary new designs, demonstrate technologies adapted to problems at hand. They reveal an aptitude for adapting to an unexpected environment and improvising with limited materials at hand. Making-do may have started as a method of survival but soon became central to an Australian cultural narrative of resourcefulness and ingenuity.

However, many criticise the relevance of making-do to a changing society. For instance, making-do is commonly regarded as resolutely masculine (Thomson 2002; Jackson 2006; Bollen et al 2008). Jackson notes how 'many writers have referred to 'rough and ready' local designs with a certain measure of pride, as if this characteristic in some way attested to their masculinity' (2006:253). In addition to being strongly gendered, Jackson argues it is colonial, white and deeply embedded in the Australian outback. He calls it a 'myth' and a 'national delusion' and takes particular grievance that it is still a widely accepted and celebrated approach to Australian innovation and design some 200 years after its British inception. Most importantly for this chapter is the fact he considers it tired, out of date and unreflective of an advanced multi-cultural society and laments the fact that the media still deploy it. Talking about Bicentennial celebrations in 1988 he writes: 'It is rather sobering, however, that the rural while male constructs of the Australian national identity were *still* promoted by the Australian popular media and as recently as this' (2006:251). Highlighting the suburban reality of Australian life he questions why there are far fewer representations of innovative Australians as urban 'hi-tech people' (ibid).

This chapter responds to his criticisms by revealing a contemporary version of making-do in suburban Australia – that of modding. Because WiFi is constantly breaking, needs fixing and adapting, it is closely aligned to the traditional concept of making-do, yet it has undergone some changes. In this thesis, it has become an everyday mundane approach to how a new digital technology is made. Making-do has been modernised.

This is not the first time making-do has been modernised. An award winning Australian documentary *Bush Mechanics* about the daily activities of a group of young aboriginal men from the Yuendumu community in remote Central Australia presents contemporary instantiation of making-do. Hawkin's (2005) writes:

> Funny, innovative, and full of self-parody, *Bush Mechanics* reveals a completely different set of car practices from those usually seen and celebrated on commercial TV. There are no high-speed chases here, no glossy celebrations of the car as commodity fetish – rather, a set of madcap adventures about driving in the desert in cars chronically on the verge of mechanical collapse. The main content comes from watching these "bush mechanics" solve a variety of technical problems using whatever they can lay their hands on. Punctured inner tubes are replaced with densely matted spinifex grass, brake fluid is made from laundry detergent mixed with water, replacement parts are found on abandoned wrecks that are part of the collective memory in remote desert spaces. All this is evidence of a playful inventiveness prompted not simply by need but also by a robust practical knowledge about various ways of keeping a car moving (2005:87).

Although this documentary provides a lens into Australian culture of adaptation as made by a group of aboriginal makers, it still places it firmly in the Outback where it retains a certain exoticism. What is unique about Air-Stream is the mundane everydayness of making-do. In fact, Air-Stream's practice of modding provides a version of making-do that is resolutely suburban. As a result, although it retains its masculinity and whiteness, it discards some of its rural and colonial aspects.

The Air-Stream network appears open to everyone, and women are clearly entwined in how it is made, yet the masculine culture of making-do provides another explanation as to why WiFi 'sticks' to men (Faulkner 2003, 2006). Looking at Faulkner's (2006) research of gender in-balance in the engineering industry provides further insights. In a brochure produced for the engineering industry to assist in the recruitment of women, she argues that the traditional hands-on 'nuts and bolts' identity of engineering, does not reflect contemporary practice and moreover, serves to alienate women: 'Arguably, the 'nuts and bolts' identity is a comfortably 'masculine' one for many men, but it can serve to exclude other engineers because it does not to capture the diversity of engineering work' (2006:2). The fact that she points out that not all men are comfortable with this approach indicates that it has the effect of attracting not all men, but only a certain type and therefore alienates more than just women. Air-Stream members do not appear to recognize the masculine comfort and pleasure that derives from their making-do approach to WiFi. This complicates their task of attracting new potential makers, such as women and men who do not embrace this version of making-do culture.

One explanation for Air-Stream members' ease with and indeed pleasure in the constant instability of the network and their ability to adapt to changing conditions can be explained in relation to making-do. It also suggests that Australian men 'take' to WiFi in ways reminiscent of how Trinidadians took to the internet (Miller and Slater 2000). Miller and Slater describe how national and cultural identity is central to understanding the internet in Trinidad. Specifically, they found that 'being Trini was crucial to people's encounter with

the internet' (2000:85). Because Trinidadian's saw the internet as being about chatting and that is what Trinidadians did, they had a hard time thinking about it as being useful for anything else. Miller and Slater revealed how they have a 'natural affinity' to it because they thought about the internet as 'naturally Trinidadian' (2000:2).

There are other unique characteristics of making-do with WiFi that appeal to Australian men. Because of the weather, Australian life is largely lived outside and means that WiFi activities can take place at more times and in safer conditions than in other places in which the weather is mostly wet and cold. Because a lot of installations are located in backyards, it means that tinkering can take place at anytime coupled with the Australian predilection for barbeques, serves to reinforce WiFi as fun and not work. Backyards, as I have previously argued by drawing on literature surrounding Australian shed culture (Thomson 2002, 2002b, 2006, 20007, 2007b, 2008; Bell and Dourish 2006), are places in which masculinity is produced. Related to this is the fact that Adelaide's unusually large suburban blocks, often featuring a shed filled with all manner of useful materials, supports messy tinkering with technology. The character of Adelaide's architecture also lends itself to making-do with WiFi. Although one of the first planned capital cities in Australia, and renowned for its Victorian architecture, there are far fewer building restrictions in place that limit building work, in comparison for example to older heritage cities in Europe or the UK. The propensity of single storey dwellings with large flat rooftops in Adelaide also plays a role in that they enable easier access than those of multi-storey dwellings in higher density cities. This means that installing an antenna on a house or shed or even building a seven metre steel tower and embedding it in two square metres of concrete in the backyard is possible.

Conclusion

Air-Stream members do not cover up or erase their traces. They leave things open, unlocked, ready for new use, misuse, and reinterpretation or application. Fluidity underpins their relationship to, and with, the technology. The possibility of change poses opportunities, not disaster which means the culture that surrounds WiFi encourages people to participate, not just use it. Exposing the work-in-progress, or what I have called middlework, makes it easy to experiment and make mistakes without fear of breaking the system. Paradoxically, in this culture, mess and mistakes are highly valued. Dave's node illustrates how resourcefulness and ingenuity are central to the way members make WiFi. Although building an antenna out of old, found and repurposed materials generates its own unique series of problems, it also helped transition Dave from 'newbie' to node.

Introducing the idea of making-do, I have argued that the acceptance and familiarity with which members work with instability and messiness is a 'natural' Australian approach for this specific group to technology development. The concept of making-do is premised on constantly challenging and changing circumstances therefore it fits well with the unpredictability of the WiFi network. WiFi serves to revive and re-interpret existing understandings of making-do in contemporary suburban Australia. 'Making-do' gives members a greater sense of stability because they are certain of their ability to tackle problems. The concept of making-do is premised on constantly challenging and changing circumstances. Therefore it fits well with the unpredictability of the WiFi network. Building on the last chapter, I have identified a pleasure that derives from constant instability because it gives members opportunities to tackle an ever-changing series of challenges and problems with new and creative solutions. I have also shown how well making-do fits with the places in which Air-Stream members make WiFi. The backyard, with a shed at one end and the domestic sphere at the other, provides access to a wide array of materials needed. What is also evident in this chapter is how easily the barbeque occupies this backyard as it did the quadrangle at the school, and the important role it plays in how Air-Stream members make WiFi.

This chapter explored how in exposing middlework, Air-Stream members rework conventional understandings of the role of visual objects in the construction of knowledge. I have shown how Air-Stream inscriptions display coherence with STS processes of inscribing knowledge and at the same time retain elements of mess, ambiguity and multiplicity. I argue that it is in this way that mess is made constant and critical to the production of Air-Stream knowledge. Air-Stream's representations show *ways* of *making* WiFi. There is no dominant, linear or central path to travel. Members are expected to make up their own stories as they go along, to apply their own resourceful ingenuity to constantly emerging uncertainties and contingencies and most importantly to share them with others. Although Tim, Jason and 'a few mates' were the original members and designers of Air-Stream, there is little evidence that they control the group. Highlighting the role and importance of middlework, therefore, does not simply add complexity or complicate STS literatures on visual culture. It is neither an accident nor a consequence of a fragile technology or the unstable character of volunteer membership. It is not a by-product of the network or natural coincidence of the group. Instead, it is the result of multiple contingencies, deliberately built into the network and central to how the group innovates.

Chapter Seven.

Stumbling in digital suburbia

This chapter examines 'stumbling'. Stumbling is a routine Air-Stream activity designed to look for and represent wireless digital 'noise' in specific sites as a precursor to, depending on the strength and direction of local wireless signals, the installation of a new or upgrade of an existing antenna. Drawing on Cartwright (1995), I compare stumbling with the X-ray as a technology for inscribing new forms of visual knowledge previously invisible and unknowable. I argue that stumbling can be considered an inscription device because it produces representations of suburbia that members use to expand the network. Yet, contrary to much STS literature, Air-Stream's representations do not narrow information or impose a particular way of seeing for the purpose of diagnosis or control. Instead, they render visible a new form of digital suburbia that member's use to imagine alternative forms of connectivity between disparate distributed points. Furthermore, because stumbling represents a version of WiFi that has escaped domestic captivity I conclude by suggesting it is feral infrastructure. This lens enables a way of seeing and understanding whom else inhabits these invisible infrastructures and the power struggles that take place within them.

Visualising 'wireless noise'

Like many front yards in suburban Adelaide, during fieldwork in 2006 and 2007, mine bore the visual signs of grade three water restrictions[33]. Due to chronic water shortages, sprinklers were banned and only hand-held hoses could be used twice a week for three-hour periods before nine in the morning and after six at night. There was no water to waste and by mid season, the drought-ridden grass bore a striking resemblance to the dusty cement driveway. Despite the relentless heat, I, like many of my neighbours, still used my front yard as an extra room, extending my domestic footprint all the way to the fence. The recycling bins by the driveway, freshly washed clothes hanging in the walnut tree and the presence of a fold-up chair point to some of the ways it was regularly inhabited and used. The actions of Ben, an Air-Stream member, who came to visit one afternoon, however, did not fit with any of these activities. In fact, they reflected something else entirely. The way he lapped the yard in the scorching heat, waving a small black stick in one hand connected by a cable to a laptop in the other, paused, changed direction and occasionally muttered - his movements mimicked those of a high tech water dowser (Fig. 37). Ben *was* looking for something in the surrounds of my house. But it was not water. What he was hoping to find, however, was just

[33] Dripper systems and hand-held hoses fitted with a trigger nozzle could be used for a maximum of three hours a week during the following times: Even numbered houses - Tuesday and Saturday (6-9am or 6-9pm) and odd numbered houses - Wednesday and Sunday (6-9am or 6-9pm). Watering cans and buckets can be used at any day/time. (Accessed 06.09.07, Available at http://www.Sawater.com.au)

as precious and hidden to those without knowledge and appropriate equipment. He was looking for wireless 'noise'.

Fig. 37. Ben stumbles for wireless 'noise' in a suburban yard (19.11.06).

Before I explain how it is possible that Ben might 'look' for and 'see' wireless 'noise' and what exactly he is doing, I need to jump back a little to explain why he was doing it. I expressed interest in getting connected to the Air-Stream network at a monthly meeting. Several members asked me where I lived and in what type of dwelling. When I told them of my location on the northwest fringe of the city's public parklands and the structure of my single storey brick and stone house typical of the area, many shook their heads. Even though central Adelaide is primarily flat, I learnt my suburb lay in a ditch and my house being low to the ground meant the chance of 'seeing' a nearby node in the area was slim. As outlined in Chapter Five, buildings, trees and other topographical nuances inhibit connection and individual points need to 'see' each other in order to share data. Given my situation, I was therefore surprised by the comments that followed:

> *'But, you might be able to see APANA' [a nearby node on a university building].*
>
> *'You could be lucky'.*
>
> *'You should do a stumble' (Field notes 18.10.06).*

'Stumbling' is a regular technique used by Air-Stream members to detect and render visible the invisible wireless spectrum or 'noise' that inhabits the air around a particular site. It is an activity employed at potential node locations, to fine-tune connection at existing ones and to upgrade equipment at key sites. Specifically, it involves measuring the microwave signals that emit from wireless devices. From the resulting textual and graphic data, members can determine the location, direction, strength and quality of local signals and armed with this knowledge, ascertain what kinds of wireless work would be required to get new nodes connected to the network. This includes what type of antenna is needed, at what height to install it and the optimum direction it should point to connect to the network. Importantly, you do not have to know if you can connect before stumbling, you can simply 'have a look around' which is what Ben offered to do. Specifically, he was looking for several Air-Stream nodes, which according to the Network Node Map, were located nearby. 'There's always a chance' he said, echoing the sentiments of members at the meeting. The use of the words, might, could, should, lucky and chance suggest there is no such thing as no way of getting connected. There is always a *way* and in most cases, several ways. This chapter explores how and why this is the case and how it relates to the visual culture of the group.

Defining stumbling

Stumbling is interchangeably known by a range of names including 'sweeping the sky', 'sweeping', 'scanning' and 'site surveying'. Ben explains it as 'getting out there and trying something which you don't necessarily know if it's going to work' (Interview 01.03.07). On the Air-Stream website, it says:

> [a] site survey is the process of measuring which microwave signals emitted from Air-Stream Servers are accessible from your handheld antenna and laptop. Also the strength and quality are assessed.
>
> [It] is often referred to as a stumble because you can stumble across wireless networks that you didn't know about before. (Accessed 10.03.07. Available at http://www.air-stream.org.au/stumbling_kit).

Stumbling invites us to think about what occupies the air around a particular site. It makes possible new ways of considering the presence of invisible networks in suburbia and the possibility to engage with them in new ways. The fact that several names describe the same technique fits with what I have highlighted in previous chapters about the presence of multiple co-located knowledge. In this case, they are all machinations of the mundane *and* the exotic. For instance, sweeping, an otherwise unremarkable everyday domestic practice of cleaning becomes extraordinary when performed on the sky. Similarly, stumbling is commonly defined as a 'mistake', a 'trip' or to 'walk unsteadily' (Oxford 2001:901). Because it is not as dramatic as a fall, it is viewed as accidental, of little consequence and easily forgotten. It is therefore striking to consider stumbling as a meticulously planned activity and Air-Stream as a group that stumble on purpose.

Fig. 38. Simon demo's how to stumble with a stumbling rig (28.02.07).

In Chapter Four, I described how the portal was deliberately designed for people to accidentally 'stumble' across and 'discover' the group (Field notes 28.02.07). I argued that because it was one of a range of co-existing and contradictory materials of the network, it revealed the challenges members face in reaching a diverse and disparate audience inside as well as outside the group. The portal highlights the intent that underpins a seemingly random array of materials. Similarly, to stumble in this chapter, is not a haphazard series of events but rather deliberate and pre-meditated – a keenly orchestrated accident.

Vergunst (2008) writes about the routine happenstance of 'trips', 'mishaps' and 'slips' in the experience of hill walking. Although an integral aspect of walking, he notes how no one ever plans to slip or trip, yet it regularly happens and because it is so mundane, it 'can easily be passed over' (ibid). The central tenet of his argument is not about deliberate accidents as such but about how, together, these incidents produce the 'actuality of walking itself' (2008:106). Ignoring or overlooking them has the effect of distancing the walker from the character of the environment and their place within it. He writes, 'by a tiny movement or disjuncture, a slip between a boot and the shale, and the character of the walk changes radically' (2008:105). Focusing on these aspects of walking draws attention to the way the body accommodates changing conditions and affords a new way of thinking about and understanding an otherwise taken for granted experience. Here, an awareness of (accidental) mishaps serves to bring the walker closer to the experience. Whereas, Vergunst (2008) concentrates on encounters with the physical landscape, a focus on Air-Stream's deliberate stumbles opens up new ways of participating in a digital landscape.

Further to the absence of a single term or distinctive definition for stumbling, it will come as no surprise that there is no definitive stumbling 'rig' or 'setup'. Stumbling sometimes relies on a single device, sometimes an assembly of devices; it can be as small as a hand held computer or as large as a number of differently configured antennas connected to a laptop. Air-Stream's website provides an outline of the range of equipment and Fig. 38 shows Simon demonstrating a 'typical' stumbling rig made available on loan to all Air-Stream members. The fact that he physically demonstrated the rig, in addition to writing about it on the website, signals the important role of the body, and body movements in stumbling. Dan provides an illustrative example:

> D: For the most part most people stumble with a small laptop because that is easier to manage and get connected to some sort of antenna nearby and often you'll be sitting down and trying to manage it with a laptop in one hand and an antenna in the other.
>
> K: Sitting down on what?

> D: Usually on a roof, usually on your knees, balancing it like this [mimics squatting with his feet apart, his laptop on his knees while holding an antenna in his hand]. Or else I'll balance my laptop in the back of my bag. Because my antenna is on the apex of the house, so I'll sit on the other side with a laptop, just more or less resting on the eaves, on the back of my laptop. There's a pole on the apex so I can just spin the antenna around on the pole. That's how I stumble at my house. (Interview with Dan 26.02.07)

Stumbling is never the same. Dan's account makes clear how stumbling relies heavily on the body-skills of the stumbler and is shaped by the textures of suburban infrastructure. It demands specialised knowledge of the rooftop and body knowledge. As a result, it is sometimes dangerous. Consider how the Air-Stream website stresses the dangers of stumbling:

> Even for simple acts such as holding a ladder or calling for tools it is a good idea to have a buddy present. **Stumbling can be dangerous**. Air-Stream will not accept liability for injuries sustained while undertaking wireless site surveys or installs, but recommends using best practise which includes identifying hazards and risk minimisation. This includes wearing a harness, stumbling during dry and daylight conditions, always having at least two firm footholds and a handhold and safe use of electrical equipment. (Accessed 10.03.07, Available at: http://www.air-stream.org.au/stumbling_rig, emphasis in original)

Defining stumbling is a complex and contradictory task. The configuration of equipment, the skills of the stumbler and the location of the stumble, the nominal output are all forms of visual representation and because the output of stumbling is 'directly usable in an argument' it is, according to Latour and Woolgar's definition, an inscription device (1979:51).

Defining noise

So what exactly is seen and how is it visualised when Air-Stream members stumble? Stumblers use NetStumbler, an open source computer software to detect and represent wireless noise in textual and graphic data. It reveals the name of the signal, which channel it is operating on, speed, vendor or maker of the device if applicable, type of antenna, whether is 'locked' [closed] or open to public use and the signal strength (Fig. 39). Equipped with an assembly of antennas, software, cables and computer, this is how Ben is able to 'look' for 'noise' in my yard.

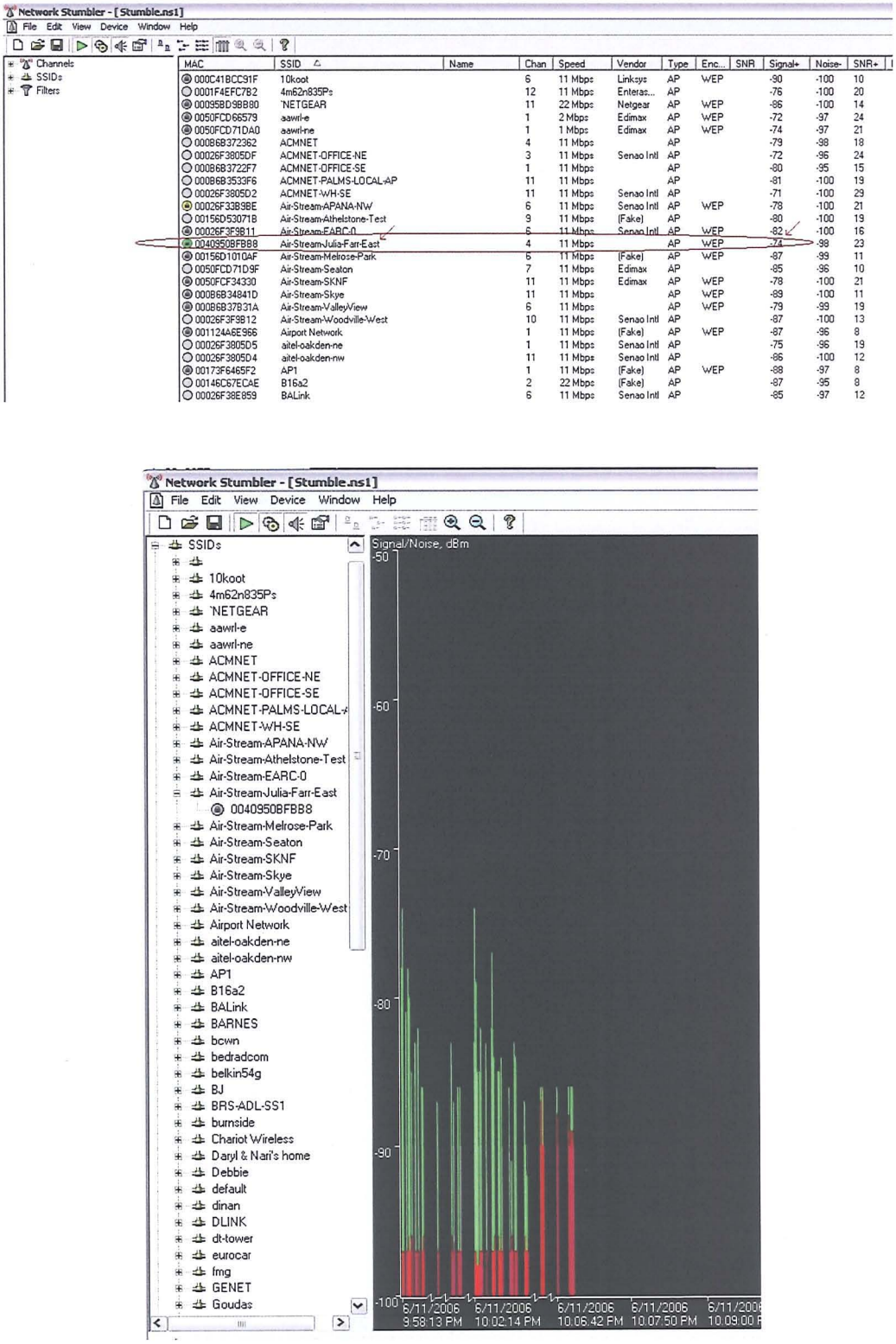


Fig. 39. Screengrabs from NetStumbler on the Air-Stream website illustrating a textual and graphic display of wireless 'noise' (Accessed 15.06.08, Available at: http://www.air-stream.org.au/stumbling_software).

Because WiFi operates on a shared public spectrum, community groups like Air-Stream are not the sole users. They share it with local ISPs, ham operators and a plethora of wireless devices that broadcast electromagnetic signals within localised zones. It is therefore not uncommon for signals to interfere or disrupt other signals. What this means is that what is a signal to Air-Stream members might in fact be background noise to other spectrum users. Several incidents occurred during fieldwork to reinforce this point for me. Members were accused by a local ISP, as well as a ham radio operator, of 'polluting' the communal garden spectrum with 'unnecessary interference' and 'digital rubbish' (Accessed 28.10.06, Available at: http://www.sir-stream.org.au/node/851).

Here, Ron explains the nature of the dispute with the ISP:

> R: I think it's really a misunderstanding about what the group is about. They think that we're doing is what there're doing which is completely wrong and we're doing it for free and it's a conflict of their business interests. They thought the demographic that we are providing services to was the same as theirs and that we were providing services that we don't. People become involved in Air-Stream for different reasons. Because some members share the internet, they [ISP] thought we were doing a similar kind of thing.
>
> K: Even though you have never said that on the website?
>
> R: No, No, we've never said that and actually discourage that. [Air-Stream] is all about local content and learning about the technology and experimenting and playing with it and doing that sort of stuff. So their [ISP] main gripe, their main strategy was to discredit what we did, as a bunch of amateurs, hobbyists, and we were using amplifiers and inappropriate equipment, causing interference, which interfered with their services.
>
> K: Sharing the spectrum?
>
> R: Yeah, sharing the spectrum. And as anything from a microwave oven to a lot of baby monitors [who share the spectrum], it's really quite ridiculous to make such a claim. Anyway [it was their way] to discourage people from being involved in community wireless and also make up for the issues they were having with their own clients. I think they see that a community wireless network is counterproductive to their business and creating more pollution of the spectrum and so on and because they are a business who for some reasons think they have a greater right. There are a lot of business people who believe that if you charge for something you have more rights and privileges, are more professional or do something better because they charge for it than citizens who do something for free. And we all know there are some truths to it but generally it's not the case (Interview with Ron 07.03.07).

Ron's explanation serves to illustrate the complex socio-political frameworks that inhabit the shared electromagnetic spectrum across Adelaide. It is not unlike Haring's (2007) writing on ham radio hobbyists, whose signals occasionally 'strayed' into television and other radio frequencies causing distress and anxiety to those outside the group: 'Without realising it, a hobbyist chatting on the airwaves might produce a series of beeps and buzzes on the channel where his neighbour had hoped to find the night's baseball game on the radio' (2007:page xiii). It is therefore ironic that a local ham radio hobbyist views Air-Stream activity

polluting the spectrum. This example reveals how new digital infrastructures are neither empty nor neutral. Just because you cannot see them does not mean they are not there. They are inhabited by many actors all of whom are active participants in a rigorously defined hierarchical system. These power struggles also show that such systems are not without conflict. And neither are they static, but rather produced and reproduced on a regular basis.

In fact, there is so much wireless noise in Adelaide that according to the Air-Stream website if you do not detect anything then 'chances are your stumbling rig is not working properly' (Accessed 10.03.07, http://www.air-stream.org.au/stumbling_rig). In line with this, the task shifts from seeing wireless noise to deciphering it. More specifically, stumblers must be able to disentangle a usable 'signal' from 'background noise'.

> Stumbling software also allows you to see the received signal strength intensity 'RSSI' or signal strength. Along with the signal you will also see a certain amount of background noise. Ideally you want all signal and no noise. Or at least more signal than noise, hence we have a signal to noise ratio (SNR) we want a really high SNR (Accessed 10.03.07, http://www.air-stream.org.au/stumbling_rig).

What emerges in an attempt by Air-Stream to define signal from noise is the awareness of a digital presence that blankets suburbia. British designer Anthony Dunne's *Faraday Chair: Negative Radio,* renders visible the rarity of 'empty space', devoid of electromagnetic spectrum (Dunne 1999). His installation, comprising a glass box coated in conductive ink, had the user lie curled in a foetal position, breathing through a tube. It revealed 'the discomfort of the retreat from electronic space, and the lack of visible difference between space that includes radio waves and a space that does not' (Joyce 2007:83). Joyce employs Dunne's work to imagine 'what radio waves look like, and what kind of space they occupy' however, she conceptualises it as an intangible and non-visual space (ibid).

For Joyce (2007), the power of Dunne's work stems from the inability to escape from the pervasive and threatening presence of something that cannot be seen. The novelty of Air-Stream's practice of stumbling lies in the visualisation of this invisible infrastructural web that inhabits suburbia. It domesticates this wireless landscape into everyday life, just as fences, electricity cables and driveways form the infrastructural patterns of every life. Moreover, the fact that members render it visible for the purpose of establishing new nodes and ultimately expanding the network provocatively presents it not as a threatening force from which individuals need protection, but rather as inviting new ways of thinking about infrastructure and the promise of connectivity.

Star has argued that infrastructures are often overlooked because they are considered 'singularly unexciting' (1999:377). Partially this is because they have taken the mode of pipes supplying water or sewerage and cables that channel electricity and phone data, which means they are either hidden in the landscape and architecture of the home or have become so ubiquitous they are rendered invisible. Although we are fully aware of how these infrastructures furnish essential services we are also content to ignore them until such times as they fail or breakdown. Writing about sewerage, Hawkins notes: 'The removal of waste, while bureaucratically managed, takes place largely in secret' (2005:46). He pursues questions about these hidden infrastructures arguing that 'unexpected experiences of waste can disrupt habits and trigger new relations and perceptions' (2005:16). This suggests that new things happen when you start to see them. In line with Hawkins (2005) and Star (1999) who argues that 'studying the unstudied' renders systems visible and, therefore, valid for sociological study, stumbling affords a lens into other ways of considering and participating in suburban systems of everyday life. Specifically, it invites new ways to explore connectivity.

The mundane everydayness of stumbling

To Ben, and others in the group, stumbling is constructed as a mundane and everyday practice. As explained by Michael, 'mundane technologies have lost their novelty and now linger in the background, doing their 'job', largely outside the intense glaring attempts to capture the exotic' (2000:3). To better understand why stumbling is mundane to Ben, it helps to understand how he got involved and participates in the group. A member since he was in the final year of high school, five years ago, Ben, now twenty-two years old stumbles on average once a month. He always carries around his stumbling 'kit' in his van 'just in case' someone needs him to 'take a look around'. Along with Daz, another member of Air-Stream, he is the most active stumbler in the group. He explains:

> I do a lot of stumbles for people. People usually get in contact with me through the website. The website seems pretty good at finding people who want to get stumbled. They post going I'm here, I'm interested, what should I do. So me and Daz go, 'Oh yeah, yeah, that's pretty close to here. Do you want to stumble or would you like us to come around and do a stumble?' And usually they go, 'Yeah, yeah'. So we make a time or whatever (Interview with Ben 01.03.08).

Getting people connected to the network motivates Ben to stumble. It is his way of contributing to the network and is comparable to how Craig invests money and Peter drives people around. Ben believes 'the more people that are on, the more ftps [uploaded content]

and the more people to play games with' will make for 'a better community'. Although computer gaming 'kicked off' his interest in WiFi, it has since changed into what he calls 'community spirit'. To him success is couched not in terms of free or in cheap access to the internet but in terms of a collaborative and co-created community that share infrastructure and the content of a wireless network. He explains:

> Basically we're wiping out the middleman. You set up your own equipment, your own links, your own setup. You don't have to pay to use it. Yeah, basically having to pay to use is annoying. It's better to pay for a one off setup and just use it. I prefer things like that rather than having to pay every time you use it. You know, licensing for software, how you have to buy a licence and own a licence for a certain amount of time. I just don't like that. It's heaps better this way (Interview with Ben 01.03.08).

Ben arrived at my house by car from a weekend near the beach where he was staying with friends. He had 'drunk a bit' and was tired but it was okay because he had 'done this heaps of times' (Field notes 19.11.06). We had arranged his visit by email and it was constructed as nothing special. He almost made it sound boring and asked to see my tallbikes as if by way of making the afternoon more interesting for him.

Together we unloaded his van and lay a range of equipment on the grass (Figs. 40, 41, 42). Ben's toolbox, a standard plastic box with several compartments and clear lid, contained a computer mouse, soldering iron, cables, wire cutters, shifting spanner, cable ties, pens, paper, motherboard, small beige boxed modem, three rolls of electrical tape, a box cutter and various loose nuts and screws. His laptop, a black IBM computer notebook, was charged and loaded with NetStumbler. He also brought three antennas (Fig. 43). The largest and by far the most professional looking one was a black grid dish by *Hills*, a local manufacturer. Yet, on closer inspection I noticed it was split down the centre and held together with black sticky tape. Ben was careful to hold it at a certain angle and told me it was no longer part of a 'proper setup' because it was 'kind of broken' but it still 'does the job'. According to Ben, the particular job this antenna does was 'sweep the sky vertically' (Field notes 19.11.06).

The second antenna, a small black stick about twenty centimetres long, was a mobile car antenna equipped with a circular magnetic base designed to affix to the roof with the wires running through the window to a laptop on the passenger seat. Ben, like other members, used it to 'wardrive' around the city looking for wireless signals. I was introduced to 'wardriving' a few weeks earlier. On the way to Software Freedom Day I travelled with Ron, who thought I might be interested in 'seeing what is around' (Field notes 16.09.06). During the fifteen minute trip, we 'picked up' a total of four hundred and forty six wireless signals. Five years ago, there might only have been one or two in these suburban areas and

they would have been commercial. Given the names of the signals were 'Betty', 'David's wireless' and 'Belkin162', [the default name of some consumer hardware], the majority are now privately owned and provides ample proof of the escalation of wireless 'noise' in suburbia (Field notes 16.09.06). In the context of my yard, the small magnetic stick antenna was to be used for 'horizontal stumbles'.

The third, and by far the most unusual and unlikely looking antenna, was a 'cantenna'. Ben made it using half an old 'milo tin' [a popular malt beverage]. Called an 'omni', short for omni-directional antenna, it was to be used to scan the air in multiple directions. Covered in a thick layer of rust that came off on our hands, and peeling yellow sticky tape that bound the jagged edge to prevent it slicing fingers, Ben confirmed 'it works better than it looks'. With the cables untangled, Ben prepared to connect the first antenna to the laptop. This unlikely looking ensemble was thus transformed into an operating 'stumbling rig'.

Reconfiguring suburbia

> *Ben takes three steps and stops. He raises the broken dish antenna above his head. Another four steps. Stop. The antenna in one hand turns in elegant figure eight swoops. The laptop remains steady in the other. He reaches the fence and turns. More steps. He traverses my front yard in a zigzag fashion, waving a series of antennas one after another. Ben is not looking at my yard but rather in my yard. He is looking at what is in it. He calls out what he can see.*
>
> *'Microwaves'.*
>
> *'Cordless phones'.*
>
> *'Linksys'.*
>
> *'Madhouse'.*
>
> *'Ovingham' (Field notes 18.11.06).*

Ben is making visible and known the digital contents of my suburban yard. While NetStumbler renders this data in graphic and text form, he makes it audible. Radio waves from my neighbour's oven and cordless phone inhabit my yard. Similarly present are wireless networks. Two are my neighbours' and one is my flatmate's. My yard is digitally messy, but not as messy as other places Ben has stumbled. He told me he regularly found 'noise' transmitting from baby monitors, hand held radios, ham radio operators, walkie-talkies, commercial wireless broadcasts and even heart monitors. Traditional boundaries like windows, doors and fences are not relevant in this wireless landscape. Radio signals leach out of the houses around us. They seep through walls, slide through fences and into my yard.

What Ben is documenting is in fact digital leakage. Although wireless devices can be 'locked' to prevent unofficial use, they cannot be held in one place.

Moving around we traced how signals changed in strength and weakness close to the fence, the bins and near the driveway, how they overlap and tangle in different corners of my yard. Operating on a shared spectrum means signals can interfere with one another. They can even cancel each other out at points in my yard. Rather than being fixed and solid, these digital architectures are permeable, malleable and transitory. The logic of space and place are reconfigured as a series of messy contingent entities.

That afternoon I discovered things in my yard about which I had not known. Within the perimeter of my house, I could see into my neighbour's lives. I could not see personal details but I could see the names they have given their wireless systems and the types of devices operating, which pieced together provide insights into the technologies that augment their daily activities. Stumbling reveals how digital suburbia is unbounded by conventional notions of ownership; mortgages, buildings, lawns and fences. It has little to do with other infrastructures and services that run into and out of the house. The digital traces Ben stumbled upon do not follow the roads or the lines of connecting fences. Air-Stream's network is similarly unbounded – it operates via line-of-site and therefore re-inscribes alternate techniques for connecting points. It cannot be understood in terms of traditional infrastructures and systems of knowledge. It poses something entirely different.

Stumbling does not present the common vision of mundane and much maligned suburbia (Weber 1992; Elder 2007; McKay 2008; Turnball 2008). Instead it provides a heightened awareness of, and access to a digital version of suburbia. Seeing into my yard in a way not possible before is similar to the advent of X-ray, which provided unprecedented access to the interior of the body. In her study of the X-ray, Cartwright (1995) writes: 'I consider X-ray technology as a pervasive and perverse cultural apparatus – one that confounds the distinctions between the public and the private; specialised knowledge and popular fantasy; and scientific discourse, high art, and popular culture' (Cartwright 1995:107). Just as the X-ray was generative of 'new configurations of the body', the practice of stumbling produces new ways of seeing and knowing the suburban landscape (ibid).

Fig. 40. Unpacking the stumbling rig from the van (19.11.06).

Fig. 41. Setting up on the lawn (19.11.06).

Fig. 42. Ben's home-made *cantenna* (19.11.06).

Fig. 43. Three antennas: Hills dish, cantenna and small magnetic car antenna (19.11.06).

Stumbling encourages a new understanding of suburbia. Just as peeking over the fence permits me to peer into neighbouring backyards, Ben's antennas and laptop enabled us to peek into surrounding digital spaces. Gathering data of this kind, available without trespass on private property, stumbling provides a new, unique and privileged view of suburbia. Cartwright (1995) points out the 'perverse spectatorial pleasure of X-ray researchers and the public confronted with the static X-ray photograph' (1995:108). While previously this kind of pervasive scrutiny of suburbia was possible only by large corporations, provided by a centralised panoptical infrastructure, Ben's actions demonstrates the relative ease at which Air-Stream members can access a wide variety of information. Moreover, they can do it from within the edges of their own homes.

Despite finding copious wireless noise, Ben shook his head and muttered unenthusiastically. He cannot find what we are looking for in the digital composition of my yard. However, just because we have been unsuccessful so far, it does not mean that I cannot get connected. Ben says we need to 'go higher'.

> *Using a wooden ladder from the garage, Ben shimmies between the sunshade and the overhanging veranda at the front of the house and onto the corner of the roof, carefully navigating the connecting gutters and flashing. I pass him the laptop and three antennas, which he balances on the lintel over the garage. Picking up two antennas and his laptop, he scampers up the roof. I follow with the remaining antenna and my camera, taking slower and more cautious steps along the dry and dusty ridgeline that is hot underfoot. I note that the tiles are not terracotta, but pressed aluminium which renders them even more fragile. A tell tale trail of dents across the roof is evidence we are not the first ones up here. The loop from the front of the house to the back reveals the journey of a heavy-footed digital TV installer who bolted a bracket and dish to the brick chimney. Ben points to the dish and says 'it's a shame' it is not installed higher up because 'we could've used that' (Field notes 18.11.06).*

Going higher means climbing up onto the tiled roof of the single storey house in which I spent my fieldwork and offers the possibility of stumbling into more wireless noise that would otherwise be interrupted by the architecture of the house, trees and other large buildings (Fig. 44). Although I noted how radio signals slip through and around houses, walls and fences to occupy, mostly uninvited, new territories such as my front yard, they also lose strength in the process or are entirely blocked. Ben's comments suggest the roof is no different to the backyard in this respect. Air-Stream members are always on the lookout for potential materials that can be incorporated into the network. Much like Reg's tree node, existing roof infrastructure, in the form of television antennas and even chimneys, if they are in the right place can be built into WiFi setups. The suburban rooftop not only encloses, protects and surrounds space it is also integral to making WiFi.

At the highest point of the roof, we see yet another version of suburbia. The landscape is a mottled fabric of fenced quarter acre blocks, single storey corrugated iron roof or red tiled houses and trees, backyards filled with fruit trees, chicken runs, vegetable patches, outdoor sun shades, sheds, children's toys and (mostly empty) in-ground pools. The soundscape, given it is another Sunday afternoon, consists of yapping dogs, lawn mowers and kids squealing. Although we are looking for a digital version of suburbia, we cannot ignore other versions that co-exist.

I had barely found a position at the top, crouched on the edge of the crown of the roof, when Ben started to stumble (Figs. 45, 46). In one hand he balanced an open laptop, with the other he looped the antennas in lazy horizontally and vertical circles. He squatted and changed the position of his feet to stumble in the other direction. His movements were slow and sure, elegant and unhurried. The only difference to the yard is the fact we were perilously perched on the crest of the roof located over five metres above the ground.

Fig. 44. We 'go higher', onto the roof (19.11.06).

Fig. 45. Ben balances on the peak on a suburban rooftop in Adelaide (19.11.06).

Fig. 46. Ben stumbles with different antennas and the laptop (19.11.06).

Landscapes of possibility

In an attempt to define stumbling I noted a range of devices in the form of antennas, computers and software, a location, the ability to interpret 'signal' from 'noise'. What emerges on the roof is the necessity for flexibility and a head for heights. While the rooftop appears to be a mundane and everyday location for Ben, my field notes tell a very different story:

> *Although we are only on top of a single storey house, maybe five metres above the ground, I am keenly aware of the height – it feels dangerous up here. The roof tiles slope to the edges of the house and there is nothing to stop me from falling off if I were to accidentally start to slide. The fact it is a really hot afternoon doesn't help. I'm sweating and my skin picks up dirt and dust from the tiles making my hands and feet red. Instead of it making it easier to grip, my dusty bare feet slip on the tiles and my fingers are splayed in a telltale grip on either side of me. In preparation for the climb I put my camera on a lanyard around my neck, which is ideal, but I'm wearing a long frock which is much less well thought out. I am torn by my split desire to hold on to the roof and let go in order to take photos. Ben doesn't seem to think this is a particularly steep roof. He has 'been up much worse' and tells me some stories about the 'worst roofs' that involve lightening, rain and wind storms, slippery tiles and extreme heights but I cannot remember them afterwards because I am too caught up in the experience and potential of complete chaos, trips to casualty, broken limbs and how I might explain to the owner of the house if he falls through the roof (Field notes 19.11.06).*

It is striking that Ben was completely comfortable on the roof while I was less so. This was at odds with a previous experience at a decommission water tower where, as an Air-Stream 'dogsbody', I climbed thin steel rung ladders between double height floors and also helped wind overflowing milk-crates of equipment through the open central core of the five storey building. At this time I was also riding tallbikes with the freakbikers - further evidence of my lack of fear of heights. Yet, this field note reveals something else. Things that are visceral and tangible to me are invisible and inconsequential to Ben. Conversely, things that are making themselves visible and known to him are lost to me. Ben treated the roof just as he did the front yard. He wandered around, swinging his laptop and antennas above his head, all the while talking of what he could and could not see. The roof was so familiar and ordinary to Ben that he barely noticed it. One way to understand this involves a cultural interpretation of the Australian rooftop and associated local practices. Having lived in London for over ten years, later I realised I had forgotten about rooftops as a domesticated space. Briefly analysing the Australian rooftop, and my response to it, reveals the edges of the everyday and opens up new ways of seeing the wireless landscape.

I propose the dangers of the rooftop for Ben disappeared for two reasons. Firstly, danger is trumped by what is revealed. Cartwright (1995) tells the story of Edison, Dally and other scientists who sacrificed their own bodies in gruesome experiments with early X-rays. She argues that what drove them to 'pursue a technology that demonstrated so clearly its

potential for bodily destruction and death was not only the thrill of seeing the deathly spectacle of the skeletal system but also the potential to harness the physiological force of the ray as a medical treatment – that is, radiation treatment' (1995:110). Although, not as grisly as the effects of experimental X-ray, nevertheless the danger of the rooftop is similarly offset by the thrill of seeing the unseeable.

Secondly, the rooftop was so boringly normal that it ceased to be a strange or alien landscape for Ben. Even being tired after a long weekend of partying, did not render the roof dangerous or subversive. An explanation for this resides in the typical architectures of this suburban city. As noted by Hall (2007), Adelaide is predominantly made up of single storey houses on large residential blocks. This means that rooftops are individually owned and maintained and are relatively accessible from the ground. Hall (2007) notes that examples of new British suburbs, in Letchworth and Chelmsford, had back gardens in excess of even traditional Australian suburbs with average footprints of thirty per cent but some were as low as twelve per cent. This is possible because these dwellings are primarily two or more storeys in construction. Although it provides more outside space around the dwelling, it also means that the roofscape is smaller, steeper and significantly more dangerous. As a result it is much less accessible. Even when roofs are part of communal blocks of flats, health and safety regulations limit access to them. What this illustrates is that the roof is literally much less of a working space in the UK than in Australia.

In contrast, in Australia, rooftops are ordinary domestic spaces in everyday suburban life. Like the yard, the garage and the kitchen they are sites of daily chores. Roofs have long held television and radio antennas, channelling electronic data from the skies into the house. When storms or possums strike, these infrastructures require that someone climbs up and adjusts the anchors that hold it in place. Gutters need attention on a regular basis. With the worsening drought, rainwater tanks are no longer the preserve of farms or remote homesteads, and instead are increasingly found in local suburbs. This means that gutters do more work than simply channel water into drains. They provide a life support system, which means they need to be regularly cleaned of leaves and possum-proofed[34] to ensure they work efficiently. In times of bushfire, gutters are also enrolled in fighting fires. Emergency services direct owners to hose roofs and wedge tennis balls in drainage pipes to dampen potential kindling, creating water channels that prevent flying sparks from erupting into spot fires. Rooftops are prime surfaces for the collection of energy with the installation of solar

[34] Some gutters need to be covered in chicken wire to stop possums from jumping on them and breaking them.

panels and many houses also make use of ceiling skylights for natural lighting. All of these activities require regular maintenance and support the idea that the roof space is a site of household tasks and responsibilities. Less well known is the idea of the roof as a site of social and cultural production. During holidays, it is not uncommon for the roof to operate as a social space complete with blankets, the barbeque and popcorn to watch local fireworks and prior to skin cancer awareness it was a private sunbaking spot. All of these activities plus the fact that a neighbour, who spotted Ben and I on the roof with what must have appeared to be a curious collection of devices, cheerfully waved at us instead of calling the police, points to an Australian familiarity with rooftops and goes some way to explain why Ben was so comfortable up there.

In line with this, it is therefore unsurprising that the suburban rooftop is a central location for Australian WiFi work. For Air-Stream members, the roof delivers ample space that is accessible, cost free and most importantly high off the ground, which is essential in seeking wireless line of sight between points. Although some Air-Stream nodes are installed in office buildings and retail centres, the majority of the community network nodes are located on top of members' houses and sheds. Apart from constructing a stand-alone tower or lodging an antenna in a tree, the roof offers the highest point that is easily available to an Air-Stream member. When Ben says that he has experienced roofs that are much 'worse' than mine, he is telling me about the many different spaces that members incorporate into their practice. No roof is off limits. Even ones that are not built for domestic access are potential sites for new nodes. Moreover, existing furnishings in the form of chimneys, eaves and television antennas, provide handy adaptable infrastructures. Every roof offers a potentially new view across the city and with it a different digital panorama. Thus, every roof presents an entry point to a digital suburban landscape of possibility.

It is also important to note that this insight emerged as a result of long-term ethnographic enquiry combined with my local knowledge of growing up in Australian suburbia. Little is written about suburban rooftops in Australian sociological or cultural studies. Again, this might be due to the fact that they are mundane and ordinary places that are taken for granted in daily life. It was also not a field site in which I thought I would be spending so much time. In line with Hess (2002), the rooftop is one of many constantly unfolding field sites that emerged during my field work to offer new and surprising insights into how Air-Stream make WiFi.

Inscribing hope, chance and possibility

> *In the kitchen, over beer and cashews, Ben shows me what he saw on the roof. His laptop is open on the bench with two windows on display (text and graphic data), my laptop is open to a Google map of the area and a paper copy of the network node map lies between them. Using my laptop he locates the Air-Stream website and the Network Map. On his laptop he explains using both graphic and textual displays produced by Netstumbler, the names, direction and strength of different signals. Although there was a lot of 'noise' outside the house, Ben says there is nothing I can use to connect into the network, but this does not mean I cannot get connected. There is still 'a chance'. He suggests I install an 'omni' as high as I can and 'see who can see me' (Field notes 19.11.06).*

Paradoxically, Ben wanted me to believe the information embedded in the representations and also to ignore it. He did not give up hope that I could connect to the network, even though the representations of 'noise' produced by NetStumbler clearly indicate otherwise (Fig. 47). Instead, he recommended a course of action I could take which would give me a chance to be seen by others and simultaneously grow the network. Throughout the afternoon Ben stressed how stumbling from my garden and rooftop produces a completely different view on the network to any other site and furthermore that if he was to stumble here again in a month, a day or even in an hour, it would possibly result in a whole different series of data. So how do we make sense of such slippery and contradictory knowledge?

Ben pointed out that even if we saw a 'signal' on the roof or in the yard, getting connected is still not guaranteed. He reminded me that there is nothing certain, binding or immutable about stumbling. Although this practice produces data that in turn provides knowledge about digital noise in the sky around my house, it does not fully capture or fix what is out there. It cannot hold it. By suggesting I install an antenna despite evidence to the contrary, Ben was encouraging me to embrace the ambiguity of the technology.

Cartwright (1995) describes how the X-ray was institutionalised 'as a form of diagnosis', 'a fetish object *and* as a powerful means of disciplining the body' (1995:123). At the same time X-ray itself was seen as a 'wild, unknown natural force that had to be harnessed and managed in order to be put to good use' (1995:110). On both accounts, it is represented in terms of control and management. It facilitated the 'management and control of bodies through imaging' (ibid). Scientists imposed themselves upon it in order to make it work successfully and then imposed it upon the body, often their own. In contrast, stumbling produces representations that are significantly less dominating. Ben did not subjugate or attempt to harness wireless noise, nor does he narrowly interpret the results. He did not impose himself upon the spectrum but rather reveals what already exists and what might be possible. Once rendered visible, he set about weaving a new antenna into the visualised

fabric of the digital landscape. It is less about diagnosing a problem and more about opening up a range of expansive possibilities.

Like the X-ray, stumbling penetrates the surface of the suburban body and opens it up to view in ways previously not possible. Like X-rays, stumbling produced snap-shots of a very particular moment in time. However, unlike the X-ray, stumbling is not a one-way, linear process: it is dialogic. When Ben suggested I should 'see who can see me', he reminded me that I am not the only one with access into the digital landscape. Others could see me. The network can be viewed from multiple directions.

Stumbling reveals digital suburbia *and* invents a new landscape at the same time. Ben uses the representations of the landscape to construct a vision of the network that suits my particular perspective on the digital suburbia and fits with my predicament. Rather than being led by the data, he shapes it into a series of responses. What emerges is the idea that the visual representations produced by stumbling are inscribed with chance and possibility.

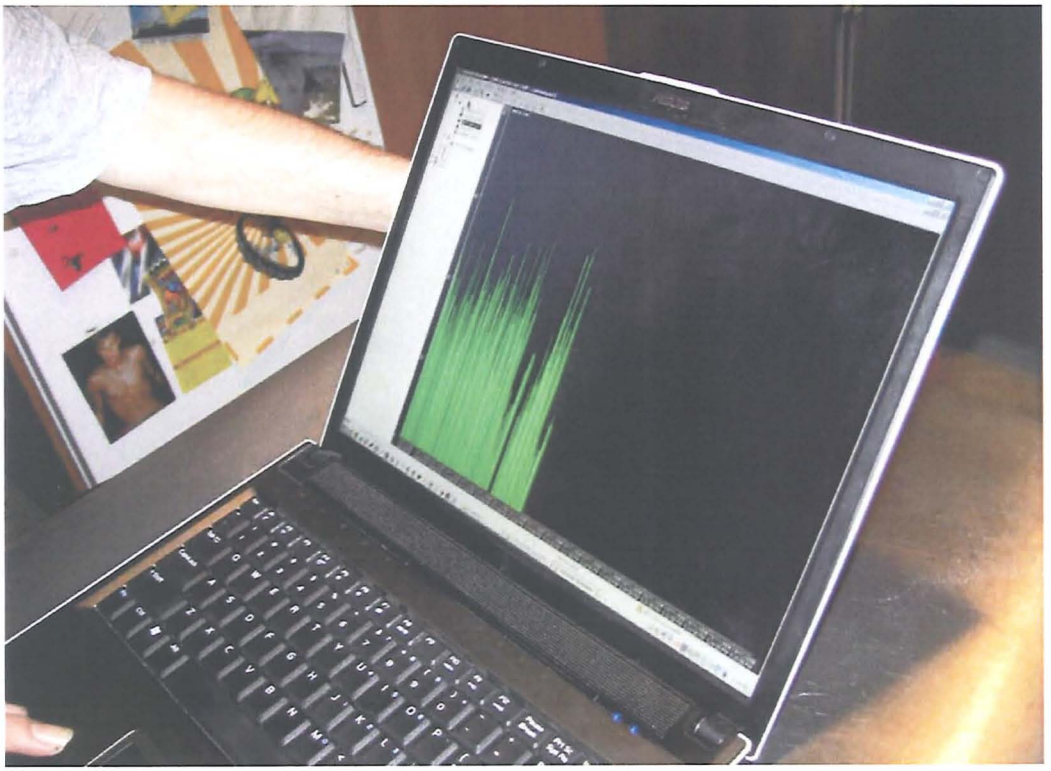


Fig. 47. Results from the stumble (19.11.06).

The following are further examples:

> It's important to keep people excited because if you say, 'I don't think it's going to work', then they're not going to spend the money and they're not going to try and I'd rather get people to try because if you put something up now and you can't connect then someone else might see it. And that's how I build the network and from my experience that's the best way to go. If you put something up and you let people find you then there's your link. You've got your first link and that might connect you to the network or it might not (Interview with Craig 05.03.07).

> This guy helped me modify it to make it suitable and then I put it on the roof and gathered all the other parts together and it seemed to work. Actually, I set it up not knowing if I'd be able to connect but just out of interest but with the hope that one day I'd be able to connect somewhere. Because I live out in Woop Woop [a long way away] and my other friend was talking about it and he lived seven kilometres away from me. This was in year 12 and I thought, allright I'm just going to buy the gear because he is just going to go on talking about it. Because that's the kind of person he is. So I was like I'm going to get off my arse and put it up and hopefully he will do the same. So I did that I was playing around with it. And one day about two months after I put the gear up I actually picked something up and it was an Air-Stream access point about 27k's away (Interview with Reg 06.03.07).

> I stumble and if there is such a low signal that 'Ahhhhh, maybe try later or something'. So I try and get people to stick up an omni, right, and then we'd do some more stumbling from other sites. Because that's what you do if someone can't get on. You then go to other spots and try and pick them up. And then you get a radio map of where they can transmit to and then you set up a relay point to get them on. But a lot of people aren't keen to do that. They just don't seem to want to. They go, 'Ah no, its too much effort', or 'I don't want to set up an omni'. So I just hope there are more APs [access points or antennas] around that pop up (Interview with Ben 1.03.07).

The role of representations in this context is not just about capturing and holding facts like inscriptions, instead because they organise actions they appear more akin to conscriptions. However, the idea of chance, hope and possibility jar with the more definitive and concise characteristics of conscription as seen in practice by Henderson's (1999) engineers. While Ben is continually keeping alive the possibility of connecting, conscriptions 'influence the structure of the work and who may participate in it' (1999:27). Air-Stream members do not employ stumbling simply as a way of representing a single reality, but as a means to expand the network. The visual representations produced as a result of the stumble do not operate as a 'yes' or 'no' answer, but rather serve to provide information that enables the stumbler to 'see' the digital suburban landscape and then use it to find ways to get connected. The question is therefore not 'Can I get connected?' but instead, '*How* can I get connected?' Far from closing or narrowing down alternatives and choice, stumbling serves to open up multiple expansive landscapes of connectivity. It is telling that members do not seek to order or discipline what they find but rather seek to weave new nodes into an existing landscape. Stumbling reveals a new visual landscape in which new connections can be explored.

These accounts illustrate how representations attract and then stick people together, regardless of the status of connection. It expands my argument from Chapter Three, where I

identified connected, disconnected and unconnected people who were united by the group's visual culture. Here, I show how never getting connected is also a valid position within the group because there is always a hope or chance of getting connected.

Building a collaborative technology

So far I have explored Ben's efforts to expand the network by encouraging me to embrace the unknown and forge ahead with an antenna regardless of my inability to 'see' anything. I now draw briefly on Kevin's experiences to further develop this idea. Although a 'newbie' to the group, he is also highly experienced in IT. He provides computer support at several charities and is currently studying IT at TAFE [Technical College]. As noted in Chapter Four, Kevin is aware that he 'lives off the map', meaning there is little chance he could see the network from anywhere around the shed out the back of his parent's house where he lives. Yet this has not stopped him from imagining other ways to get connected. He explains his many ideas:

> Kevin: I used to be able to see Mount Barker from the top of the shed. Until the trees grew I would have been able to bounce off Mount Barker if Air-Stream could get wireless gear up there. That's assuming I only run gear off the shed because the house already has *Foxtel* [Digital TV company] gear on it and if I was to take that dish down and potentially realign it and put it somewhere else on the roof, I'd be able to bounce off the house over to Mount Barker. Or potentially, I could get a higher line of sight to someone else on the hill opposite. We can also see a local industrial estate, which is over here on this sadly out of scale map [the one he is drawing]. Again, although I can probably bounce off that to Mount Barker it's getting something into one of these places to bounce from.
>
> Kat: How will you go about finding a place to bounce off in these locations that you describe?
>
> Kevin: It depends on how bold I am about it. The mechanic I take my car to is in the industrial area. If he owns that building, he might be willing to put something up on the roof. Or I could go and do similar to what Pat is thinking about doing in his area, and that's letterboxing (Interview with Kevin 22.02.07).

Kevin totally rejects the impossibility of getting connected. He lists a remarkable array of possible strategies and activities including bouncing signals from different points, modding existing antennas, letterboxing, targeting key people and moving house. Like Ben, Kevin exhibits extraordinary persistence in exploring alternative ways of getting connected and his solutions are reliant on a myriad of contingencies. Being 'bold', for instance, apart from being an intriguing choice of word in relation to wireless technology, relates to the fact that in order to get connected to the network Kevin will have to socially engage new actors, such as the local mechanic at a nearby industrial estate, and this will require daring and confidence. Kevin cannot get connected on his own. But there is a chance he can with the help of others. This account reinforces what emerged in Chapter Six in Dave's backyard

about the importance of enlisting volunteers and familial support. Just as Dave could not build, raise or connect his antenna on his own, Kevin relies upon a larger social network to connect into the network. What is new in this chapter, however, is how Kevin has to extend his networks to strangers, who have not displayed any interest in WiFi, thus predicating the need for boldness. And this is not unusual course of action in the group:

> Just because you can't see the network doesn't mean that you can't connect to the network. It's about finding other people who can and getting them and then connecting off them (Interview with Ron 16.01.06).

Both examples illustrate how Air-Stream is making a very different kind of technological infrastructure – a collaborative one. In may ways this means there are no limits as to how far it can extend across Adelaide.

Collaboration is pivotal to the making of Air-Stream's WiFi network. Getting connected to the network requires an intensity of engagement not ordinarily encompassed in the purchase and use of commercial WiFi package. You do not simply *get* connected. You need to *give* time, tools, the roof of your house, electricity, investment of materials and money. You also need help – volunteers and family are vital in physically building and raising an antenna. And as it turns out, imagination and more than a little bit of hope are also important. In Chapter Four I showed how connection is not a condition of membership. Chapter Five revealed how connection is shaped by a myriad of instable actors and Chapter Six further highlighted how connection, even when it is achieved, is never certain or fixed. Now, connection is never impossible and, furthermore, is shaped by chance and being bold.

I was under the impression that I had to connect to the network as part of my fieldwork. I assumed I would, that it would not be too hard, and the experience of doing it, as well as actually being on the network, would constitute part of my analysis. As already noted, I never achieved a connection to the network and yet, as this chapter attests, attempting to connect demonstrated my involvement in the group. By demonstrating my participation and contribution to the network there was a chance that, as Dave suggested in Chapter Six, people might 'come out of the wood work' and connect to me (Field notes 01.1106). I may not be able to 'see' any appropriate wireless noise in order to connect to the Air-Stream network but I can place myself on the map and therefore in the group. Emphasis, at this time, is clearly on connectivity over content. A point echoed by members:

> I'm not so much interested in the content, although the content is really the ultimate thing, but it's more about having this network (Interview with Ron 16.01.06).

Stumbling constructs new ways of connecting people together by re-arranging suburbia. What it reveals however is not neat or definite. It is not easily controlled. It slips and slides out of conventional architectures. It can be locked but not held in place, which means it cannot be turned on or off if it is not wanted. It does not only exist in pipes or in computers. It occupies spaces in between. And it is invisible until visually detected by an inscription device. If as Alpers (1984), has argued, a visual culture is how a group sees the world and makes it knowable, then seeing a newly configured suburban landscape, a digital suburbia, renders possible other ways of thinking about, and connecting, that circumnavigate traditional infrastructural models. Hawkins has written that our ability to define things as rubbish in order to dispose of waste 'depends on a particular kind of blindness that helps us *not* to see' (2005:80 emphasis in original). The opposite is happening here. Stumbling produces representations that help us see and imagine digital suburban landscapes.

As a result, this chapter presents a vision of WiFi that is remarkably different to the conventional commercial model presented in Chapter One (see Fig. 1). Rather than competing with traditional institutional systems, Air-Stream offers ways into the digital landscape for ordinary people through the representations made by members. Stumbling takes apart familiar and conventional notions of infrastructural systems that until now have safely and conveniently pumped services into and out of the home. These pipes and wires are built into the domestic infrastructure and into domestic practices of consumption. We know how to purchase and use them. We know who to call when they break. We also know not to touch them. Stumbling disrupts these familiar and comfortable notions. It is unsettling, messy and invites involvement; a powerful reminder of other ways in which connectivity is possible. These representations provide the means to participate in multiple ways. Thus, they display characteristics of inscriptions *and* conscriptions. However, stumbling, as per its moniker, is a practice that is purposefully open to surprise. It produces not only a representation of what exists, but what might exist.

Conclusion – A 'feral' infrastructure

As has been the case in earlier chapters, this chapter also speaks of a unique set of Australian materials, landscapes, skills and tenacity of character. Turnball (2000) uses the term 'motley' which highlights the complex, disparate and seemingly incommensurate elements which underpin the planned, rational and ordered nature of technoscientific knowledge. Drawing on empirical examples such as malaria cures, medieval architects, turbulence research and aboriginal map makers he argues that 'if we wish to rethink the way we

produce knowledge and the forms of knowledge we value, we need to recognise, even celebrate, its unplanned and messy nature' (2000:1).

Although the term 'motley' accounts for a diverse array of actors in heterogeneous science and technology networks, I argue that a more local term, 'feral', is better suited to my ethnographic study. 'Feral' commonly connotes a 'wild animal or plant' that has escaped domestication (Oxford 2001:328). Together with Bell (2008), I have written about commercial domestic models of WiFi as a 'feral' technology:

> Feral connotes a particularly grounded Australian understanding of the tensions and anxieties of wild and domesticated worlds. Like feral animals, wireless infrastructures often escape domestication, resorting to an unruly condition, requiring of the user an acute and flexible awareness of the fragile ecologies in which they reside. They only become visible to us at points of attachment with specific devices, at interruptions or interferences with other domiciled artifacts or when they are entirely absent. In no sense can they be considered stable or homogenous. To engage with them predicates an understanding of what they attract and repel, where and how these overlaps interact, what is displaced and what is revealed. To understand how they work in the home is to understand how they work with the home (Jungnickel and Bell 2008:275).

This represents a fundamental shift away from thinking of WiFi as 'plug and play' technology to one that prompts sensitive awareness of radio emissions of other devices in the home. In another work, I have described the many inexplicable 'technological tantrums' that result from the introduction of WiFi into the existing domestic ecologies and the resulting 'wireless workarounds' necessary to make possible everyday use (Jungnickel 2006).

This chapter goes one step further. It introduces a feral infrastructure. Having moved out of the home and onto the roof, Ben and I encountered an infrastructure that has entirely escaped domestic captivity. No longer contained or controlled by conventional or recognisable infrastructure, it slips and slides through and around traditional architecture: the uniform regularity of such is emblematic of successful commercial models that orchestrate the flow of materials or services in a one-way direction, deliberately designed for people to purchase and consume. In contrast, the representations produced by stumbling reveal an infrastructure gone wild. As a result, this account offers a striking contrast to what has been written about how even the smallest interruptions can cause immense disruption to stable infrastructural systems in STS (Collins and Pinch 1982; Callon 1986; Star 1991; Latour 1999). Far from catalysing anxiety or tension, the process of visualising feral infrastructure produces new ways of knowing, and in turn participating in, the digital landscape. The concept of feral infrastructure therefore suits a making-do approach and, as has been illustrated in Chapter Six, the process of modding.

The fact that a ham radio hobbyist and a local ISP complained about Air-Stream invading their wireless territory further supports the idea of Air-Stream's WiFi as a feral infrastructure. Here, Air-Stream's WiFi is feral because it is considered the intruder in an established technical landscape that has already been carved out by ISPs who are traditionally larger and more dominant and ham radio hobbyists who have been around longer than community WiFi. Although the conflict appears extreme, looking more broadly it is comparable to the way Australian customs, with its island mentality, deals with foreign fruit and animals – it eradicates or quarantines them.

STS literatures hold that techniques of rendering are interlocked with particular ways of seeing the world. Henderson argues that a visual culture 'constricts and constructs the literal ability to see or imagine' (1999:26). Similarly, Latour writes that it 'redefines both what it is to see and what there is to see (1986:8-9). In line with this, the representations produced by Air-Stream as a result of stumbling present a version of suburbia without fences, doors, houses, roads, buildings, cables, power lines and other conventional structures. However upon erasing some actors, others become more visible. And much more than wireless noise is rendered visible in Air-Stream's representations of WiFi. Prior to learning about the conflict with other wireless spectrum users I proposed that stripping away these and other familiar and mundane symbols of suburban ownership and power, collapses distance between ordinary people and infrastructure, reconstructing in its place a new digital landscape, open to chance and possibility. However, because this wireless spectrum is far from empty or neutral, another conclusion is that this study of the culture of WiFi made by backyard technologists in suburban Australia provides a lens through which power struggles in the Australian technological wireless landscape become visible and knowable.

Chapter Eight.

Homebrew high-tech

Dodgy DIYers or innovative problem solvers?

> Our national knack for invention and innovation, for making do, lives on in the shed. The 'she'll be right' attitude may be denigrated as the blight of Australian industry, but it thrives in the country's backyards (Thomson 2004:3).

As described in Chapter Six, making-do is a distinctly Australian version of DIY interlocked with the peculiarities of local conditions, landscape, weather and colonial history. Yet, as Thomson (2004, 2007) argues, making-do is perceived as a source of national pride and embarrassment. To explore how Air-Stream members fit homebrew and high-tech together, I briefly draw on colonial accounts to explain its trajectory and residual effect on contemporary understandings.

Although South Australia became known as the ''hearth' of agricultural innovation in Australia' as a result of many successful technological adaptations, Birmingham et al, (1979) note how the *Australian Settlers Handbook,* produced for early English immigrants, failed to recognise the legitimacy of these inventions.

> James Atkinson in 1826 recommended the immigrant to bring a swing plough and the irontines for a harrow to be made up from a forked log of wood. (...) Little had changed by 1861, when the *Australian Settlers handbook* recommended much of the same list: eighteen years after the invention of the stripper, the prospective settlers of New South Wales were told to bring sickles and reaping hooks, and sieves for winnowing in the breeze (1979:17 emphasis in original).

Local technologies did not make it into the handbook, which suggests that they were not considered of significant value to replace long established British agricultural knowledge. Despite widespread success, inventions like the stripper harvester were seen to be of questionable integrity because of adapted, cobbled together and re-purposed characteristics. They had been tinkered with. The very essence of what made these technologies work successfully in challenging conditions became grounds for their dismissal.

The dismissal of Australian innovation not only rests on its tinker nature but also on Australia's penal heritage with its attendant class implications. Haring (2005) suggests that socio-economic judgements play a role in the trivialisation, or in this case total rejection and subsequent erasure, of tinkered technologies. In identifying the division between people who learnt technical knowledge in classrooms and others who learnt from experience on shop floors or on their own, she writes of the distinction between an 'association of study with the wealthy and of tinkering with the working class' (2005:90). What the nature of this dispute reveals is the tension inherent in the relationship between tinkering and innovation and signals that hands-on does not naturally intersect with high-tech. Another way to view this is

through what Henderson calls the 'aura of high tech', which she argues shapes how engineers work and represent themselves (1999:196).

Henderson illustrates how a high artefact, in this case computer assisted design software (CAD), has more status than one that is considered low, such as hand drawing skills, and how this shapes the way discipline chooses to present itself. She argues it is pivotal to why engineers use CAD despite the fact they know it can never fully capture the tacit, local or personal knowledge essential for the everyday 'doing' of engineering. It does not capture the messy reality of engineering practice. Yet, the 'aura of high tech' persists in playing a pivotal role in shaping the culture of engineering. She writes, it 'constructs a vision of a great future, and because engineers want to subscribe to this source for cultural power, it is difficult for them to criticise it' (1999:1985). The combination of home-brew with high-tech that Ron, makes in this comment is therefore striking.

> It's a homebrew telecommunications network (Interview with Ron 16.01.06).

Talking about Air-Stream members who tinker with highly sophisticated technology, he highlights a curious fusion of seemingly incommensurate entities. While the former is nominally the reserve of hobbyists and amateurs in their spare time, the latter is most often associated with official and firmly established commercial organisations. As I have identified, there is a tension between tinkering and more formally acknowledged innovations. Homebrew represents one way of reconciling these tensions. Air-Stream's practices and representations from modding to stumbling are all about homebrew technology.

In the Australian context, homebrew typically refers to the brewing of beer for personal consumption on a small domestic scale or the programming and free distribution of video games by hobbyists. As the name suggests, the home is central to its practice. Ron's definition of the term homebrew, however, suggests something else. Much more is going on here than a domestic leisure or labour designation. His version of homebrew is not confined to the edges of the home and is not the sole pursuit of a lone individual in the domestic sphere. It extends out into the urban landscape and involves the whole community. Moreover, it is not a subscription service that simply works when it is plugged in. Air-Stream members are makers, not consumers.

Ron's definition of WiFi as a homebrew telecommunications network is a powerful statement. It firmly locates WiFi as a backyard technology. Building on my examples in prior chapters, this chapter argues that 'homebrew high-tech' is a distinctive Australian way

of imagining and making WiFi. Air-Stream's approach to homebrew high-tech is one that is highly localised to the suburban backyards of Adelaide. It marries a collaborative and social approach with a great willingness to tinker. Importantly, it is predicated on an understanding of WiFi as open and participatory, rather than commercial or closed.

As discussed in previous chapters, Australian WiFi is a fragile, often unpredictable and complex technology that predicates meticulous accuracy, sophisticated technical skills, the understanding of complex visual schema and access to specialised materials. It is also a technology that Air-Stream members put together in their backyards, using customised combinations of purchased, home made, found and even partially broken materials. These are startling contradictions: how do Air-Stream members negotiate the intersection of precision and tinkering? How do they straddle the DIY and professional divide? How does homebrew fit with high-tech?

English-Lueck's (2003) findings on New Zealand's 'culture of innovation' provides one ethnographic account of homebrew high-tech. Known for studying the cultures of Silicon Valley in California, she turned her attentions to New Zealand to explore its role as a silicon producer in the global economy. Although very different to Australia in terms of population, economic dependencies, weather, and indigenous culture, New Zealand shares common narratives emerging from isolation, distance and colonial encounters and thus I argue it is relevant to compare technical cultures. Of particular note is how English-Lueck identifies and recognises the legitimacy of a local hands-on approach and links it to high technology production in what she terms a 'cultural tradition of "inventive-ness"' (2003:2). She explains the basis of this distinctiveness:

> The last stop out before Antarctica, New Zealand has created a narrative around being at the 'ends of the Earth'. A tolerance for quirkiness is something that informants viewed as integral to New Zealander's ability to innovate. Niche research and development are key to New Zealand's place in the global silicon network (2003:4).

Here, New Zealand's isolation is seen as central to its culture of innovation. Crucially, she interprets an aptitude for local ingenuity, adaptive reuse and problem solving as highly regarded attributes in the global technology marketplace. Innovations do not have to be completely revolutionary or new, instead value is perceived in unique re-combinations of existing materials and problems.

> They do not develop revolutionary technologies, but refashion and apply existing ones. Examples include creating a technology for spraying bees with precise amounts of pollen to deliver to crops, converting airbag sensors into cheap but sensitive seismic detectors, niche search engines, or programs that can record and reproduce key strokes (2003:4).

To further explain this culture of innovation, English-Lueck draws parallels with a New Zealand national icon – a popular and ubiquitous gauge of wire used for fencing the edges of New Zealand farms and high-tech innovation. She writes, 'a rhetoric of frontier inventiveness is imbedded in the New Zealand idea that anything can be fixed with #8 fencing wire' (2003:4). Using this metaphor, she shows how New Zealand's 'quirkiness' emerges from the parameters of the social worlds in which technologists work and infuses everything that is made.

Both Australia and New Zealand's 'culture of innovation' are necessitated *and* enabled by the isolation, distance and space and materials at hand and a challenging history. They are a product of, not just as response to, the challenges of making technology work in a specific environment. From English-Lueck's (2003) study we see how a New Zealand style of 'quirkiness' visually emerges from the parameters of the natural, social and technological worlds in which programmers work. Results may not be radically transformative but they are examples of ingenious resourcefulness and innovative problem solving. Crucially, what English-Lueck demonstrates, is that these homebrew approaches to high-tech are highly regarded in global marketplace.

Sticky tape technology

The juxtaposition of 'quirkiness' in the field of 'big' science of silicon production is striking because it dispels the idea that homebrew is incommensurate to high-tech. The importance of English-Lueck's work for this thesis lies not only in recognition of alternate technology makers who innovate outside of large-scale institutions but in acknowledgement of unconventional methods and practices. Her example of fencing wire is particularly relevant as both a tool and a metaphor for innovative resourcefulness. Air-Stream members have their own version of fencing wire in sticky tape. It also represents an important way of re-imagining how innovation and inventiveness might happen in the suburbs of Australia.

> *A cordless drill, screwdriver, hammer, cable ties, a silicon gun, cable ties, sticky tape and pliers used during the day lay strewn on benches in the shed, the grass outside, across the ping-pong table and wooden garden furniture. As Simon and Dave work on the new node, I ask them which tools they most use to do this type of work. 'Sticky tape', they both say in unison (Field notes 12.11.06).*

Ben brought three antennas with him; a Hills 2.5gb dish, a small thin magnetic car antenna and a home made cantenna. Two out of three were sticky taped in some way to keep them from falling apart or slicing his fingers (Field notes 19.11.06).

When Pat discovered that his neighbours were worried that he was spying on them, he climbed up onto the roof of his house and used black tape to mask the flashing lights on his modem. (Field notes 13.08.06)

After showing photos and telling the monthly meeting about the installation of a new antenna on a challenging site, Peter says, 'It shows you don't need flash stuff, you just need sticky tape'. (Field notes 26.07.06)

It was easy to overlook the presence of sticky tape in the first few months of my fieldwork, I was otherwise distracted by what I considered to be more exotic and strange ethnographic objects. Yet, as indicated in this selection of field notes, sticky tape featured regularly in interactions, demonstrations and experiences of how Air-Stream members made WiFi. I soon discovered that this mundane and ordinary artefact was not only an accessible and cheap material highly valued by members in their everyday situated practice, but also when it was not actually used, as expressed by Peter, it was evoked as a way of working. It epitomises the kind of homebrew high-tech approach that this chapter examines.

Sticky tape is an interesting metaphor for exploring the culture involved in making WiFi because it evokes a particular method of temporarily binding things together. It is emblematic of being able to fix anything. A key theme that has emerged throughout this thesis is Air-Stream's members' comfort with instability. It manifests in multiple interpretations of connectivity, membership and even the activities of local birdlife and the weather. There is no single or dominant version of the network, or the group's visual culture. Instead, members gather together and attach themselves to contingent assemblies of multi-dimensional representations. As a result, WiFi as it is made by members of Air-Stream fits with the idea of sticky tape that temporarily holds things in place only to be removed and re-stuck again in a different configuration. Sticky tape technology fits with the idea of homebrew WiFi.

The use of sticky tape by Air-Stream members recalls what has been argued in STS about binding agents. In engineering, Henderson (1999) describes visual communication as 'glue'. In science, Latour's (1990) concept of 'circulating reference' highlights the cascading 'chains' of representations. Here, representations are comprehensively layered in cascades, each one linked to the next. These representations in these science and technology studies bind people, objects and knowledge together. They are held together by the stickiness of their visual culture. But these particular adhesives – glue and chains – are characteristically

not temporary. The use of these particular binding agents is evocative of a more permanent style of bond between objects and the people who make and use them.

Air-Stream's representations also stick people and objects together, but as per the character of sticky tape, which suggests more of a temporary fixture, the bond is differently comprised. People are not required to subscribe to the same structures or ways of working as anyone else. I argue that sticky tape does not so much impose itself upon the group as much as enable the constant development of a type of contingent practice that produces a reliable technology. The ways in which sticky tape is used to hold together pieces of WiFi also makes it an important component of modding and making-do and therefore is emblematic of a certain kind of Australian technical agility.

The place of tinkering in homebrew high-tech

> It's the whole adaptive approach. It's what I've always done (Interview with Kerry 23.02.07).
>
> When I was in year seven I think I got my first own computer that was mine and stuff to break and fix. And ever since then I've been intrigued by everything that is computers, any aspect of it. I've just wanted to get into it, to play with it and programme it or create it and know more and more about it. All of my friends at primary school and high school would always say I was the computer geek, the computer whiz. It was just who I was. You could call it a gift or a knack or something. It was just what I did (Interview with Simon 3.03.07).
>
> I broke too many things when I was young. I remember when our washing machine broke and a whole section of it was pulled out and replaced and I got to play with the broken bit. So when things used to break, like a radio or something, I used to want to open it up and see how it worked, things like that. I was always the person who gets asked to fix something, like a VCR or something, like what wire goes where? I got that last week by a workmate. He's like, 'I've got this and this and this and I want to put it all together but I don't know how' (Interview with Daz 08.03.07).

As outlined in Chapter Seven, mods and modding are common terms in Air-Stream, yet there are many overlaps with tinkering and it often, as indicated, emerged in interviews conducted with members. Tinkering is commonly known as 'part of the inquiring approach to the material world' and 'includes scavenging, scrounging, tampering, adapting, fossicking, fixing' (Thomson 2007:6). According to these interview excerpts, tinkering is not something that can be turned on or off, nor can it be learned. The fact that Air-Stream members describe it as being socialised from a young age and a predominantly male activity fits with what has been written about tinkering by Kleif and Faulkner (2003). In their study of robot builders and professional software developers, they write about how 'boys are more likely than girls to be socialised into hands-on tinkering with mechanical devices' (2003:297). Air-Stream members echo this perspective:

D: I used to try and incorporate my sister into it a little bit. She wasn't really interested in how I looked at things. I would make games so she would be involved. Like we'd play like a library game where we'd lend each other our books and I would write a computer program and she would have to come, I put in the number and record it.

K: And your sister? You said she wasn't so keen on this?

D: She just cared about the books and I just cared about writing the program (Interview with Dave 21.02.07).

However, Air-Stream tinkering practices also contradict other conventional understandings. For instance, Kleif and Faulkner point out that tinkering is a solitary affair when they write about how 'few of the men admitted to any enjoyment of or competence in working closely with people' (2003:301). This argument is reinforced in many other versions of tinkering. Even in its more modern guises, such as the popular American MAKE magazine, website and series of travelling events, tinkers send evidence of their activities in visual step-by-step instructions for others to mimic, but rarely are people shown in these images and never do groups of people appear. This example serves to reinforce the idea that tinkering takes place in isolation and out of public view. It also fits with Turkle's (1996) study about computer programmers who were individual tinkerers and Thomson's (2002, 2007) work where the shed is depicted as a refuge from domesticity and the world at large, inside of which is depicted a lone man engrossed in a task at hand.

In my opinion, what marks Air-Stream tinkerers apart is twofold and relates to their visual culture. Firstly, Air-Stream tinkering is a social experience. It is largely social, collaborative and group-oriented as evidenced by Dave's antenna raising in Chapter Six and many of the monthly meetings and other events. Often linked with a barbeque or a social meeting of some sort, tinkering regularly takes place with others. Although it is possible to stumble alone, as in Chapter Seven, Air-Stream's website recommends members take 'a buddy' onto rooftops to hold antennas and ladders in order to prevent accidents. Collaboration is encouraged and in some cases actually necessary for a job to be accomplished. Ironically, what these examples point to is the inappropriateness of the term DIY in relation to Air-Stream's backyard technologists. Air-Stream members clearly are not individuals who subscribe to a do it yourself (DIY) approach. Instead, they do it together.

Secondly, Air-Stream members routinely blur the lines between hobbyists and professionals. For them, tinkering is not something that only amateurs or hobbyists do. Nor is it just done by programmers or professionals. These categories, as I will show, are not easily defined in the context of Air-Stream, and more over, the group does not demand these distinctions are made. In fact, their visual culture serves to further blur these divisions. As argued in Chapter

Five, the Air-Stream network is specifically designed to incorporate instability and failure. Redundancy is built in which means it adapts to breakdown and blockage at different points in the distributed network. As a result, the Air-Stream network is built for tinkering. which makes it particularly attractive to a wide range of people. Reg explains:

> It's like I can test it and play around with it and do whatever and not have someone say. 'Hey you're not meant to do that', or 'You shouldn't have that case open and those wires there'. It's a lot more relaxed. And if something breaks then you and just other people around the area are going to be affected. Obviously they might be a bit disappointed that you've played with something and broken it but... (Interview with Reg 5.03.07).

Reg works full time as an IT specialist and he uses Air-Stream as a place to 'test' and 'play' with technology. In this case he is both an amateur and a professional. And he is not alone. As indicated on the map in Chapter Two and throughout this thesis, many Air-Stream members work in the IT industry and meetings were regularly frequented by people from local business, enrolled in IT courses at university or working for large telecommunication companies which makes the division between hobbyists and professionals a difficult one to sustain.

Kleif and Faulkner also identified what they term the 'fuzzy boundary' between professionals and hobbyists when they write: 'Just as many of the robot builders had jobs working with technology, so many of the software developers had technological pursuits in their out-of-work lives – they did home maintenance and remodelling, they had leisure pursuits that used the latest gadgets, and/or they read science fiction' (2007:301-302). In fact, in Air-Stream's context, such a division can only be temporally drawn. For many members, salaried IT employment takes up specific set of hours in the day, while Air-Stream is as Tim has indicated earlier, 'squeezed' in around other commitments (see Chapter Five). This is important when considered in relation to other conventional and highly pressured accounts of time. Traweek (1988), for instance, illustrates the importance of time in the making of scientific knowledge, specifically, long periods of time. She writes: 'Completing an experiment in high energy physics can take three to five years' (1988:6). Similarly engineering designs take months to years to move from drawings to finished systems or buildings. Some of Air-Stream's tinkering follows a similar arc, but much tinkering with WiFi can be spontaneous, happen the middle of the night, during weekends and holidays. It is significantly more flexible and accommodating to other commitments and pressures in everyday life. Air-Stream's culture shapes and is shaped by this concept of time. Simon explains his use of IRC:

S: It's just the chat programme we use. You can have a lot of people on a channel. Its well set out so you can easily see who's saying what.

K: How often are you on it?

S: Oh, I'm on it twenty four seven.

K: So it is open now?

S: Yep. I just jump in and see who's around. It is usually the first point of call for people. Everyone checks it. People have MSN [a Microsoft IM programme] but with IRC you can type something in the IRC server and it will sit there and when they get there they can have a look or someone else can help out (Interview with Simon 3.03.07).

Air-Stream's IRC is used by members to discuss, plan, update and share WiFi activities. It is specifically built for synchronous group conferencing. As a result it is often a source of, and platform for, representations of tinkering at all times of the day. The advantage of IRC is that it runs continually and traces of conversations are not erased, nor are they private (unless specifically intended) from the rest of the group. This means members can catch up on things they might otherwise have missed and learn from other members interactions. Being able to pick and leave off where they started suits those who are committed to other activities. The use of IRC by Air-Stream members means that tinkering does not happen in isolated blocks of time. It also means that there is a visual history of tinkering. This is another instantiation of the middlework I discussed in Chapter Six.

Building reputation

Tinkering in the context of Air-Stream is clearly a valid and important practice in which new technology development and innovation takes place – it is how Air-Stream members make WiFi. It is an important homebrew component and Air-Stream members view their activities with professional pride.

It's a hot Sunday afternoon and I'm in a lined corrugated iron shed the size of a double garage, out the back of Simons' parents house. He lives here, though it looks more like a messy home office than a bedroom. Tucked away along the left side wall is a small fold-out bed, but like the many random desks, a tatty lounge, wall units and chairs scattered around the room, it is covered in empty chip packs, plastic coke bottles, piles of CDs, keyboards, books, spare monitors and cables. Simon is sitting at the desk flicking through photos on his monitor of recent antennas he has helped to build and install. He always carries a camera with him and takes photos at every installation. He points out, in a close up shot, the details of cables that are folded 'just right', 'clipped tight', and how everything is clamped together 'all nice and neat' (Field notes 2.03.07).

Later, as Simon again pointed out the clear side panel on his external hard drive that revealed the meticulous presentation of the internal components I asked him about it:

> Because it looks professional. Especially with the Air Stream stuff because its all voluntary, we are not getting paid, and a lot of people see it, we try to make everything look as professional as possible so when they see it 'oh it must be done by a business' and then they realise it's the Air Stream equipment, 'oh wow that's impressive' (Interview with Simon 2.03.07).

Simon is quite clear that being and looking professional is one way for Air-Stream to gain legitimacy. Another Air-Stream member had a similar sense that Air-Stream technology should look professional. When I went to interview him at his workplace, on top of which an Air-Stream node is located, he made a great deal of showing-off the node;

> *Climbing through the service shaft at the top of the state government health centre we emerge on the rooftop of the 15 storey building. Given the view that stretches all the way to the Adelaide Hills I can see what Reg means by a 'good site'. I am surprised by the presence of two identical nodes on the wall. Everything from the type of pole, brand of box and dish, to the way the extra cable is curled and secured is the same. I ask if both are Air-Stream's. He smiles and shakes his head. One, is apparently owned by a local ISP. He asks me to guess which one. I can't. He asks me to guess which one was there first. It wasn't the ISP (Field notes 5.03.07).*

I knew that Ron installed this antenna, so I asked about it during an interview:

> They are using the same equipment. And I know for a fact because that equipment is owned by City ISP [altered name of local company]. A lot of his knowledge came from me, and that's why he's using the same boxes as me [laughs] (Interview with Ron 7.03.07).

What these two examples reveal is a version of tinkering that does not produce amateur work. In the first, Simon reveals the desire for highly skilled and expert results. In the second, the fact that a local commercial ISP copied the work of the local community group is testament to the proficiency and skill of backyard technologists. Of course, as is clear from previous chapters, Air-Stream members also delight in producing far less complete devices and installations.

> A lot of the other guys like Craig are really really keen on making and putting stuff together and if it works its fine or if its bodgy and there's tape hanging out the side so what, its no big deal. It works right, that's the most important thing (Interview with Kerry 23.02.07).

Kerry's account suggests that it does not matter what the object looks like, provided it does the job. For Air-Stream, tinkering, like their other activities, is also about contradictory impulses, co-located forms of knowledge and a complex array of representations. This fits with my earlier discussions of sticky tape technology. Air-Stream members are not trained in neat, linear trajectories or expected to conform to produce identical versions of the technology. Instead, individuality and resourcefulness is encouraged which means that tinkering is how Air-Stream makes homebrew high-tech.

These examples show that Air-Stream's homebrew approach is more than comparable, and in some ways even more advanced, than what might be expected of larger and more established telecommunications organisations.

'Makeaholics' and 'shopaholics'

Although the internet has been critiqued for breeding a world of consumers, the advent of Web 2.0 propagates the notion of users as broadcasters (Gilmore 2008). At least one Air-Stream member sees a similar distinction.

> We make ourselves out of our expressions. For some people these expressions are what they choose to purchase and for others it is what they generate. For spinners and weavers, guilders, open source and WiFi people, the generation of the self is closely tied to the skills you develop and what you can contribute. So you get shopaholics and makeaholics and they both buy things but they buy different things and generate different things and need different kinds of space (Interview with Jane 24.10.06).

Jane's concept of 'makeaholics' is an interesting take on making-do, sticky tape and tinkering. It also points to the challenges that Air-Stream encounters in engaging with the broader public. Because people are so used to expressing themselves as consumers, especially in terms of the internet, this makes the concept of Air-Stream difficult to explain. People tend to think of connecting in terms of a transaction. They pay for a service therefore they feel they must get something in return. As a result, members often find themselves in the role of re-educating people.

> Because it's a foreign concept. Like it's not really something you hear about every day and because people are so used to the internet they are very keen to adopt that description of it. [...] I think I read a statistic that says 10 per cent make and 90 per cent consume. So its like the majority of people don't. They just go on there and look it up. Whereas Air-Stream is about creating your own website or put images on there or you'll write something and that's why we have a website completely full of information. You create things yourself and put them on the network. You actively participate in it. You are not just a consumer. Which is a key difference I think to the internet. When you go on the internet you are just consuming webpages, consuming websites. Whereas at Air-Stream, we encourage people to make things, to produce content whether that's photos or servers or services or whatever. We like people to do that kind of thing. (Interview with Dan 27.02.07)

> Ron: We see people who think they are going to get cheap internet or are becoming a member because they are going to get a fee for service. 'Oh its fifty bucks a year and I'm going to get something from this', and they don't understand that its actually an association and you only get out of it what you put into it. But you soon see people willing to go, 'Oh I got all this information. I've got this and I've got that and I'll come out and help you set up and I've got this extra part I can lend you', and are willing to share that opening and aren't guarded about it. It's not, 'Oh I'm not going to show you how to do that because it's my little power trip'. It's more about, 'Hey do this." Then you find those people tend to go on to become more involved and when you need help with something you can call on them.

> Tim: They're the people who get things done basically. Nothing ever seems to eventuate if people are not being open about their knowledge (Interview with Ron and Tim 16.01.06).

Putting infrastructure into the realm of the ordinary and mundane provides points of attachment for people to get involved. It is not just something to consume, but a way to imagine new forms. What Dan, Ron and Tim are saying is that Air-Stream does not work unless people get involved and this requires a paradigm shift for many who subscribe to consumer models. However making your own connection is not a 'natural' or instinctive approach to technology to many.

Backyard technology in a commercial world

Specifically, here I am interested in how members navigate their role as a not-for-profit WiFi community group in relation to commercial telecommunication companies and other technology producers and also balance a desire for experimentation and the making of mistakes with their commitment to the production of a rigorously tested, robust and reliable network. As illustrated by Toronto's *Ile Sans Fil*, WiFi technology is shaped by a group's relationship with, approach to and understanding of local ISPs. In representing the making of WiFi in a particular way, Air-Stream members foster a distinct engagement with larger socio-economic and political forces. In their case, far from viewing the world as a competitive arena or alternatively, as a linear, stable and impenetrable closed system in which passive consumers await the provision of, and pay for, services from large commercial models, participation and contribution in the infrastructure itself is encouraged. Air-Stream's approach to a not-for-profit WiFi is very much a part of their larger homebrew high-tech ethos.

Air-Stream's approach is also visible in its relationships to local ISPs. While other community WiFi groups like *Ile Sans Fil* compete on a commercial scale and view success in terms of destroying their opponent's market share, Air-Stream foster a significantly more symbiotic relationship that is more in keeping with what Haring has written about ham operators in the 1950s: 'Electronics manufacturers especially, but other technical companies as well, sought to increase the number of hams on the payroll' (2007:83). The number of IT professionals who are also Air-Stream members is a more contemporary model of this. Further still, Ron believes that groups like Air-Stream would not exist without ISPs, and correspondingly, ISPs draw core knowledge from groups like Air-Stream.

> I think there is a really important place for commercial telecommunications. It just wouldn't happen at the scale that we all benefit from if it wasn't for commercial wheels driving that whole thing.
>
> I thoroughly believe that no business would be using wireless LAN for connecting business and providing internet access and hotspots if it wasn't for community people using it in the first place. It's because we've got all these designs and we've been around for a while. It was designed for extending the local network inside your business. It was never designed for long haul links and it's only been basically enthusiasts who originally built their own high bandwidth antennas and set up long haul links.
>
> It has all been driven by enthusiasts, by community minded people. It's that open source mentality in that you share information and people share information back with you. You learn more. You gain more. (...) Those business just wouldn't exist if there wasn't a community already doing it and it actually demonstrates a dependence. (Interview with Ron 23.03.06)

Ron's comments make clear the symbiotic relationship between different versions of WiFi, commercial and non-profit, that support the other. Drawing on open source ideology Ron explains how information collaboratively flows. For Air-Stream, this means the more you give the more you get in return, indicating is not hierarchical in nature. It is a shared landscape of information, which is much less competitive than the *Ile Sans Fil* model and more collaborative. Air-Stream's links are also in constant motion. Nothing is fixed or static. Knowledge is assembled and re-assembled according to who is involved and the nature of their needs. It has, what Turkle calls, more 'the flavour of a conversation than a monologue' (1995:52). In Air-Stream's case, it is a conversation between many very differently constituted and conventionally opposed bodies. Ron's comments clearly illustrate space for multiple versions of the technology. Wireless technology was never designed for long haul links yet Ron explains because Air-Stream members experiment and build their own homebrew versions that new innovations have developed. Commercial businesses rely on volunteers to innovate. How is this achieved?

Fig. 48 is an example of the high regard in which local Adelaide businesses hold the group. Local IT businesses regularly enrol Air-Stream members' tinkering skills in experimenting and testing new devices. Simon was given one of two Linksys WRT300n routers 'to play around' with. As discussed in Chapter Seven, 'playing around' is term used regularly in Air-Stream parlance to describe the process of experimentation. Like Turkle's (1995) definition of tinkering, it involves arranging and rearranging things into different configurations.

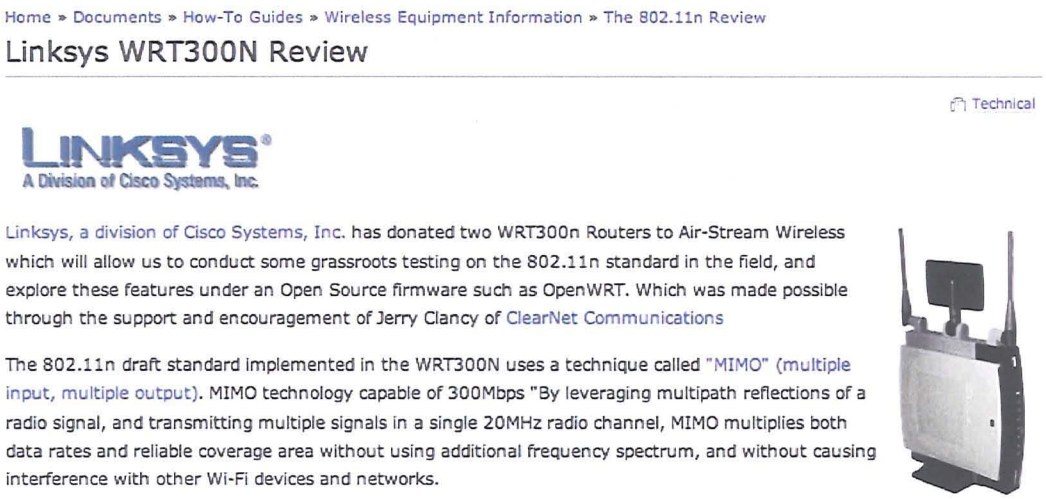


Fig. 48. Review of commercial equipment on the Air-Stream website
(Accessed 3.03.08. Available at: (http://www.air-stream.org.au/wrt300n_review)

Simon explains the fundamental role of the website in this relationship:

> So when I got them I opened up the box and pulled it to bits straight away. I had heard from someone that there was a mini PCi card in it so I worked out how to pull it apart. It's actually almost designed for pulling apart. It had spring-loaded feet that unclipped and all that sort of stuff. So I pulled it all apart and got the mini PCi card out and got it working in my laptop so that we can play around a bit. I've have left it open so we can change things again (Interview with Simon 2.03.07).

These routers are not prototypes but finished working devices. *Linksys* already know what their product can do within specific business and domestic parameters. They wanted Simon to explore the ways in which it might be used outside the boundaries with which they are familiar. They were happy with the fact he was going to take it apart and tinker with it. They were interested in *what else* it can do.

And what Simon was doing was in no way clear or defined. The fact he left the box open in order to continue to tinker reflects what I have argued about Air-Stream's sticky tape practice. Here, it further illustrates what members achieve in adopting this kind of practice – 'to show people what is in there'. As I have previously argued in Chapter Six about middlework, this involves rendering visible and public the process of making WiFi.

The result of Simon's experimentation is a document; he wrote and published a review on the website. I asked him why he thought commercial businesses do this. He explains:

> S: Because they know we are a fairly decent WiFi group. Our website ranks hugely on Google because we've got all the documentation, the WiKi and stuff. You type in the type of card and Air-Stream will be in the top three [results]. It's just been around for so long. Back in the dark ages in 2002, 2003, when there just wasn't much information around a couple of guys had got some stuff and written some stuff about it and put the details up on the website and Google generated lots of hits and lots of people linked to it because they could see that it was a good source of information, a quality source. I think we've had a couple of other pre-release and cheaper things but they are starting to realise that if they give stuff to us then people listen to us. 'Hey this is a good product. Go and buy it'. 'Oh ok'. I mean this *Linksys* stuff I'm really excited about. The tests I've done already. I'm going to write rave reviews about it (Interview with Simon 2.03.07).

Air-Stream's website provides a means through which the group builds a reputation in diverse socio-economic domains. Being not-for profit and independent means their opinion is viewed as a valid source of knowledge highly regarded by other community WiFi groups and tinkerers. No doubt *Linksys* are aware that in getting Air-Stream to review their product and potentially recommend it, they garner attention from a new and not insignificant market.

The relationship between *Linksys* and Air-Stream is manifest in Air-Stream's culture. Again, we see evidence of the indivisibility of the membrane that divides the expert from the amateur. The many local business logos on the website, the brochures and posters produced for events such as the Software Freedom Day, AGM and other public events, present further examples of symbiotic relationships. Air-Stream promotes local businesses to its members, negotiates special discounts with retailers and openly invites business people to attend meetings. Haring (2007) describes a similar overlap between amateur hams and professional radio operators.

> Hobbyists publicly promoted ties to the electronics industry to enhance their reputation for technical mastery. On the job, hams invoked the amateur persona. The particular styles of technical knowledge and practice associated with amateurs, hobbyists claimed, carried over into paid occupations. By this logic, professional success stemmed from amateur status, completely contradicting the usual meaning of amateur (2007:89).

Like the trees and the bugs and weather, I detailed in Chapter Five, here members find ways to work with and enfold local ISPs into the network. In the same way that the traditional suburban boundaries of buildings and streets are irrelevant to WiFi, the conventional divisions between professional and amateur appear not to apply to the group. Just as Wyatt reminds us that 'digital exclusion does not always mean social exclusion' (2008:11), Air-Stream reveals how backyard technology or homebrew WiFi does not mean separation from or opposition to commercial practices. Instead they have carved out a new space in between that offers another way to engage with the technology.

These examples, and those earlier in the chapter, demonstrate how Air-Stream members do not need to be professional to look professional and also highlights the importance of reputation. Craig is often the first one to respond to problems on the network because he believes the ramifications of not looking professional would damage the group's reputation and in turn damage the network.

> If there are people connected to it and want to use it and they are complaining of course I want to fix it straight away because I want them to tell their friends that Air-Stream is good. I don't want anyone bad mouthing things when we are trying to grow it. Because we get enough of that from the commercials [commercial ISPs]. Certain cowboys badmouth Air-Stream all the time (Interview with Craig 06.03.07).

Craig's comments reveal not all relationships with local ISPs are happy ones. As discussed in Chapter Seven, one company in particular views Air-Stream as 'polluting' the shared spectrum. In turn, Air-Stream members view that company's work as irresponsible, amateur and technically inept. Here are just some of the comments about this one company I noted in Air-Stream meetings during the year:

> *Dodgy geezers.*
>
> *Somewhere between pirates of the Caribbean and Adolf Hitler.*
>
> *They are cowboys.*
>
> *And that thing (their antenna) will burn birds. It's incredible.*
>
> *It's like using a sledgehammer to whack a walnut.*
>
> *It's like using monster trucks for when you need bicycles.*
>
> *You can even see the other antennas with your eyes (Field notes 26.07.06, 13.10.06, 11.01.07).*

Members critique the commercial 'one size fits all' system that results in the installation of inappropriately powerful technologies in places where they are not needed. They mock the ISPs inability to customise the technology to suit the individual location. Calling them 'cowboys' and 'pirates' represents them as amateur and unprofessional. These examples turn the tables on conventional assumptions of homebrew and high-tech. They highlight how Air-Stream members view their ability to deftly customise nodes to accommodate the subtle nuances of the materials at hand, the location, weather conditions, council restrictions, fauna and anticipated use of the technology. Here, homebrew is recognised as much more professional than commercial practice. Not only are members not waiting for commercial organisation to build the infrastructure and provide services, they are critiquing their ability and skills. This 'cowboy' exception therefore proves the rule precisely because it is specifically recognised as an exception. Although the ISP deliberately attempted to brand the

group as unprofessional, it has the opposite effect of rendering themselves unprofessional and amateur in comparison to the not-for-profit group. This makes a striking comparison to the technological example that opened this chapter.

Conclusion – Towards linked up backyards

> We've reached a point where broadcast media, broadcast product, broadcast lots of things are not a good fit anymore because the people who provide the broadcast have become too interested in generating profit out of this model to the extent that it no longer serves the people who receive that service. So people are interested in distributed ways of participating with each other to generate value. It's like we've got freeways and they work which is great but people all have backyards and driveways and its like Air-Stream is more like everybody linking up their driveways to make a freeway (Interview with Jane 19.02.07).

Jane's eloquent analogy evokes a powerful image of the Air-Stream network in contrast to large telecommunication systems that predicate single one-way piped services. Although modelled on other traditional forms of infrastructure such as electricity, water and sewerage, what is clear is that these neat and linear distribution models are not the only way in which people technically connect to one another. According to Jane, the old broadcast model is the conventional notion of an internet freeway, or superhighway, while a linked up series of individual backyards and driveways is akin to a hand-made homebrew participatory system. Her idea speaks of people dissatisfied with traditional monolithic and heavy handed systems, demanding instead, a range of locally available materials, spaces and ideas that together, offer new and easily accessible ways of encountering, navigating and most importantly contributing to a collective infrastructure. Importantly, it brings WiFi down to earth, embedding into the suburban landscape where it enables what Goggin calls, 'a rare opportunity to reverse the usual binary between commercial/public versus domestic/private use of communication technology' (2007:121).

This chapter is a powerful testament to the productive potential of backyard technologists. As English-Lueck (2003) demonstrated in her New Zealand innovation studies, the essence of innovation is not necessarily always about something new. Similarly, homebrew high-tech brings into being a technology that is unique, locally constituted and imbued with the subjectivity of the maker. What is unmistakable is that making-do and modding incorporates so much more than simply getting by or simply surviving. It is clearly about ingenuity and innovation.

This chapter also firmly located Air-Stream members as makers and not consumers. It signals how backyard tinkering can result in the production of a sophisticated technological

product, previously an exclusive enterprise of large commercial or state governed infrastructural bodies. Here, it bridges the distinct spheres of DIY and professional, with homebrew high-tech. Furthermore, Air-Stream evades many of the restrictions presented by black box technologies. The ubiquity of sticky tape revealed the way members produce technologies that everyone can get her or his hands into. The Air-Stream network is clearly built to 'serve', rather than 'impose' itself on its users and environment (de Laet and Mol 2000). But there is something else emerging in this account. What attracts me to the concept of homebrew high-tech is the small everyday ordinariness of these practices. It is not just made by backyard technologists. It is a backyard technology intervention.

Chapter Nine.

Conclusion

This concluding chapter seeks to revisit the central question posed in the thesis: Can the representations involved in making WiFi by backyard technologists be considered 'inscriptions' (Latour and Woolgar 1979) or 'conscriptions' (Henderson 1999)? During the course of my ethnography, however, the limitations of this question became evident in view of a technology characterised by ambiguity and instability. Although these influential studies initially framed this research, they do not fully account for an expanded typology, that is, the possibility of alternate forms of representations that accommodate multi-dimensional co-located and sometimes even contradictory knowledge.

This thesis extends beyond inscriptions and conscriptions by letting go stringently ordered and hierarchical accounts of two-dimensional knowledge and moving towards the recognition of a diverse array of multi-dimensional objects gathered together in contingent assemblies. I have argued against universal and uniform systems and instead draw attention to the importance of small nuanced understandings of local versions of technology development and use. In line with this, this thesis calls for recognition and acknowledgement of innovation activity undertaken outside firmly established institutional science and technology settings. As Miller and Slater argue in their ethnographic study of the internet in Trinidad 'if you want to get to the internet, don't start from there' (2000:5) – similarly, to 'get to' WiFi, this thesis started with Australian backyards and barbeques and with maps and members of Air-Stream. Moreover, I have demonstrated the validity of using visual culture as a way of getting at how members of a specific cultural group, in this case a group of backyard technologists, come to know and understand a new digital technology. As such, this thesis poses both theoretical and methodological interventions in sociological knowledge.

This chapter focuses on core themes outlined in the introduction and explored in subsequent chapters; the nature of connectivity, DIY infrastructure and the Australian cultural context and attending practices. Together these categories provide a framework for considering the role and importance of the representational culture of WiFi as made by Australian backyard technologists. It concludes by exploring the potential of mess more broadly for the craft of sociology.

Taking apart the stable notion of connectivity

One of the first aims of this research was to examine the nature of technological connectivity. Just as Mol (2002) and Law and Singleton (2005) argue ethnographically for the vague and imprecise character of the diseases they studied, this thesis on a volunteer

community wireless network challenges the idea that connectivity is in any way definite or certain. Instead, I have shown how being disconnected, unconnected or never being connected is the norm. Air-Stream's barbeque meetings are particularly illustrative of this, given the diversity of attendees who are, aren't, have never been, or are merely thinking about getting connected (p.92). Air-Stream is not a group based on the assumption of clear and certain connection. Instead, people are brought together for the purpose of *getting* connected, which reveals a broad range of connective possibilities. Furthermore, I have shown how it is Air-Stream's visual culture that sticks them together.

My research identified the presence of conflicting temporalities of Air-Stream's culture of connectivity. This is to say there is no one type of connection at any one time. Daz's connection 'comes and goes' as a result of the trees in a nearby park that interfere with his signal. Similarly, Jen is mostly connected except when her link occasionally 'drops out' prompting her to climb her backyard tower and 'jimmy' [adjust] her antenna. Evidence of temporal disjunction also emerges in Kerry's inability to achieve connection in winter but not in summer (p.118). These examples reveal how being connected and unconnected at the same time is possible, as is achieving a 'near' and even a 'non' connection. Connectivity is not uniformly distributed across the network. While some members are connected, others are not. A key example of this is Dan's discovery of the node theft (p.114). Dan was the first to discover the equipment loss, precisely because no one else noticed a problem. Everyone else remained connected. Contrary to what most STS would expect, the Air-Stream network did not spectacularly fail when a node was stolen, but instead rerouted data away from the problem. What this means is that the network is differently constituted for individuals at distributed sites around the city. As a result, connectivity in the context of the Air-Stream network cannot be understood as a clear, singular or stable entity.

Technological connectivity in media and academic scholarship has largely been seen as a matter of access (Norris 2001), pressure (Green and Harvey 1999) or choice (Wyatt et al 2002). The 'digital divide' represents a gap between haves and have-nots (Norris 2001; Servon 2002; James 2003), Green and Harvey (1999) stress those who are connected from those who are pressured to connect; and Wyatt et al (2002) unsettle the category of 'user' by describing of 'non-users', 'former users' and 'never users'. These arguments have shaped understandings of connectivity in STS literature, yet there is still an opportunity, to borrow from de Laet and Mol (2000), to question what *connectivity* might actually mean and redefine it as more than a clear-cut 'yes' or 'no' – or in this case as 'on' or 'off'. What this thesis has revealed is the possibility of multiple, shifting and uncertain connections as a

result of the 'maybe, 'kind of', 'yesterday, but not today' and 'only if it does not rain' links that frequent this thesis.

The co-presence of multiple contradictory connections intervenes in conventional understandings of temporal logics. While there are pressures from work, family and other commitments, Air-Stream activities do not follow any traditional science or technology clock for innovation and development. Science and engineering studies regularly trace the temporal trajectories that define how students are trained, devices are used and knowledge is produced. Traweek, for instance, shows how the 'anxieties about the terrible loss of time' directly shape the culture of high energy physicists (1988:17). Tied in with this is a preoccupation with progress. Science is always concerned with advancement and a similar relentless drive exists in engineering and other technology industries. Moore's Law, for instance, holds that 'the number of transistors on a chip will double about every two years' (Intel 2008). Similarly, Web 2.0, heralded as the next big internet development, is another key example (Schonfeld et al 2006). Neither Traweek's ideas of time pressures nor Intel's about regular cadence of innovation are of particular relevance to Air-Stream who make-do with time, the way they make-do with technology. This is not to say Air-Stream members are not interested in advancing their technical knowledge or in expanding the network – they are, but they are more interested in making things, or more specifically as Tim says, 'make it do something that it wasn't designed to do' (Interview 07.03.07). This goes some way to explain why getting connected to the network, although encouraged, and despite being a central promise of the WiFi technology itself, is not essential to participation in the group.

The fact that connectivity and time are not contiguous challenges the idea of WiFi as constant, 'anytime' and 'anywhere' put forth in the rhetoric by Government, media and commercial organisations (Koprowski 2004; Telstra 2007; DCITA 2008). The idea of WiFi's 'always on' connectivity is all about temporality. It relies upon the intersection of time and space; one connects to something and one expects a response. Therefore, in disaggregating the certainty of connection (as well as the internet) from WiFi, this study of Air-Stream presents an alternative to the idea of 'one size fits all' systems and practices (Schofield 2005) that dominate large-scale commercial pay-for service organisations in Australia (Goggin 2004; Goggin and Greg 2007). Air-Stream's network is not bought, unpacked and plugged in but rather is uniquely customised to each location, shaped by the available materials and skills of the makers. Each point in the network is distinct as it is clearly illustrated by Reg's tree node (p.119) and Dave's shed node (p.146). Further still, there is a *lot* of work involved in making WiFi, much of which appears disproportionate to

the return, considering the incidence of 'non', 'near' and 'sometimes' connections. Stumbling, for instance, reveals how members think nothing of spending hours on suburban rooftops in the scorching sun simply 'looking around' (p.175). To members like Ben, this is a mundane and even boring activity. Further still, Ben acknowledged that if he was to stumble again in a day or even an hour at the same spot, the results would differ. Likewise, Dave spent five years thinking about, eight months planning and $800 'so far' building his node and he did not achieve connection. It had to be taken down twice more before he was able to link into the network (p.160). These examples would be considered inefficient at best and failures at worst if read in relation to the desire for, and expectation of, constant connectivity touted by conventional technological models.

Another aspect of Air-Stream's connectivity is its local-ness. A central tenet of early internet studies was the idea of connecting to other places. Caught up in the excitement of a new technology many studies focused on the other worlds and identities made possible through the internet (Turkle 1995). In response, studies of environments such as internet cafes and businesses sought to establish the local in the global (Wakeford 1999; Miller and Slater 2000). The study of the Air-Stream network follows this theme. It connects people as close as a few blocks of one another and as far as a few suburbs apart. This is how Air-Stream makes 'our net not the internet'. It is a very local internet. As a result, it presents a striking contrast to how the internet has been positioned as a tool for globalisation. In the introduction I set out to study a volunteer community wireless group in order to gain a sense of grassroots technology production. I argued that they were bringing WiFi down to earth. This term came from STS ethnographies that sought to ground an understanding of how science was made. In studying a volunteer community group I have shown how members make WiFi literally in their own backyards.

A multidimensional culture of connectivity

Inspired by Star, this study also set out to go beyond 'the traditional purview of field studies' (1999:378), which I argued emphasised internet content, and instead explore internet infrastructure more commonly overlooked and undervalued. Although I set out to conduct an ethnography of WiFi infrastructure, this thesis is more an ethnography of connectivity – specifically how Australian backyard technologists strive to connect distributed points across a local suburban landscape. Because, as I have argued, connection is neither static nor stable, it is the critical role of Air-Stream's culture to stick members together. Representations are central to how Air-Stream make WiFi. Yet, unlike Latour and

Woolgar's (1979) inscriptions, equivalences are conceived not by transforming raw materials into infinitely comparable and combinable visual representations, but by gathering together many different multi-dimensional materials. In this way, Air-Stream's representational culture echoes the co-located, overlapping and occasionally contradictory characteristics of its technical network. Key examples include the contrasting range of Air-Stream merchandise on sale at the barbeque meeting (p.107), multiple designs of the portal (p.115) and the many maps, diagrams and photos available on the website and at public events.

This thesis also set out to explore, drawing on the concept of conscriptions, the ways representational culture might play a role in determining who can and who can not participant in wireless developments. I identified several instances in which representations, in many forms, were used to attract new members. The merchandise at the meeting was not limited to members or even those who could connect to the network. Similarly, the diverse array of representations made available at public events and on the website was described by Tim as a deliberate strategy of attachment to include rather than exclude new people (p.110). The lack of non-members similarly pointed to the inclusiveness of Air-Stream's representational culture, as did the distributed nature of the portal at distributed nodes across Adelaide. In Chapter Five, I introduced the Air-Stream concept of 'tagging' people by way of visual activities (p.132). However, unlike conscriptions, I argued that tagging signalled the enrolment of not one way but multiple ways people could participate in the network, and moreover these tags were not fixed. Throughout this thesis, I provided examples of the way Air-Stream's culture sticks people together, but not in chains or glue as identified by Latour and Woolgar (1979) and Henderson (1999). Air-Stream's tactic, characterised by the mods (p.143) and stickytape (p.206), all point to more temporal adhesives that are easily adapted in changing conditions.

This thesis expands the dimensional characteristics of inscriptions and conscriptions previously acknowledged in STS of visual culture. Visual culture is defined as the way 'a culture *sees* the *world* and makes it visible' (Latour 1990:30, emphasis in original). Although such a statement suggest infinite and dynamic elucidation of ideas, the typology of visual knowledge objects is largely confined to text, maps, sketches, drawings and images: a two dimensional vocabulary for a multi-dimensional world. It is a world, as Chaplin notes, in which 'the verbal analyses the visual' (1994:2). It omits a broad spectrum of expression for subjects and methods of study. Air-Stream members' knowledge takes a myriad of forms, including drawings, maps, diagrams, photos, demo's, bodies, nodes, stumbling 'rigs',

the website, IM, modem boxes, tools and materials and merchandise. To make sense of this complex array of objects required an ability to analyse across three-dimensions, two-dimensions, single dimensions and on occasion, in the form of radio signals, no-dimensions. So rather than imposing upon or demanding conformity of its members, Air-Stream's culture gathers together and forges connections between incommensurate actors such that they make sense not to a select few but to a diverse and distributed audience located inside *and* outside the group. It is a culture that is richly social, temporal and multi-dimensionally material. Although public exposure presents threats to the network, such as the thefts that began this thesis, members accommodate and enfold them into the materials they make thus diffusing their ability to destabilise the system. Overall there is no single and definitive version of the culture of Air-Stream connectivity. It is better characterised by multi-dimensional overlapping contingent assemblies.

Messiness as a way of explaining Air-Stream's backyard technologists

Connectivity, in the context of Air-Stream, recalls the multiple, instable, fluid and fire like characteristics of ANT studies (Singleton 1998; Mol 2002; Law 2004; Law and Singleton 2005). As with Mol's (2002) notion of multiplicity, Air-Stream unsettles the idea of WiFi as a single stable entity with complex and contradictory representations of connectivity. However, while Mol's metaphor of multiplicity is a spatial one, I have shown that Air-Stream's version of multiplicity is visual, spatial and temporal. Echoing Singleton (1998), I highlighted Air-Stream's co-existing instable and stable characteristics. Although unpredictability is recognised as essential to the durability of the CSP programme in Singleton's study, it was securely hidden behind the scenes. In contrast, Air-Stream's middlework was rendered public. Recalling de Laet and Mol's (2000) Bush Pump 'B', Air-Stream reveals how WiFi 'works' in fluid ways. Yet, I have shown that the Air-Stream network does not fluidly change at different points, but rather, is made different from the beginning. These contrasting and dramatic shifts and changes could be characterised in terms of Law and Singleton's (2005) fire objects. However, the fact that members can be simultaneously connected and unconnected at the same time means that these presences and absences co-exist. Although these interpretive lenses were useful, none perfectly suited my analysis of the ways in which Air-Stream members make WiFi.

All of these studies fit with what Law (2004) calls mess. He contends that the world is made of uncertain, instable and multiple actors and advocates the need for a 'broader, looser and more generous' ways of understanding them that does not set limits on understanding

(2004:4). Mess, according to Law, is not something to be tidied up but instead viewed as an interpretive lens into socio-technical culture. He draws on ANT literatures to recognize and express the potential of messiness for sociological knowledge.

Air-Stream's co-located and contradictory contingent assemblies of connectivity fit with Law's idea of mess. For instance, the barbeque meeting appeared disordered due to the absence of a definitive time frame (p.87), no one sat in the same seats and there were many representations present, none of which cohered to any identifiable ordered arrangement (p.102). In line with Law (2004), this kind of messiness provides one way of understanding the nature of my research. However, in doing this ethnography and presenting ideas back to members, I found it did not fit with Air-Stream. Members rejected my ideas of mess. It was not a term they used to express their modes of practice. They did not view WiFi as ambiguous, disconnection as a cause for anxiety or their material practices as messy. It was not how the group represents 'itself to itself' (Alpers 1984:page xxv). Mess is not part of Air-Stream's representational culture per se.

Why is this? If they do not acknowledge mess, how then, do they represent themselves to themselves? What is particular about the group? What is unique about how Air-Stream make WiFi? In answer to these questions, I suggest a central reason as to why mess is not recognised by members of Air-Stream relates to the third theme in this thesis – the Australian cultural context and attending practices. Throughout, I have drawn attention to the practice of modding, making-do, the important role of backyards, barbeques and homebrew tinkering. Using these, I develop a framework for considering WiFi as an Australian backyard technology.

The Australian cultural context and attending practices - Towards an Australian WiFi

This thesis established the presence of an Australian WiFi. During fieldwork, many Australian actors particular to Adelaide emerged in making WiFi. I described several instances in which familiar elements of suburban living found their way into a newly developing digital technology. Flyscreen, sticky tape, biscuit tin boxes and Hills Hoist [clothes line] wire are just a few enrolled in the everyday making of Air-Stream's WiFi network. I also described the barbeque as a quintessential social and collaborative framework that gives shapes to WiFi events and thus to Air-Stream's connectivity. Likewise, birds, local wind, long summer months, eucalyptus gum trees and even bugs were

incorporated in daily decision making processes. Air-Stream's WiFi network is clearly shaped by knowledge of, and sensitivity to, the local landscape and its inhabitants.

But it is not simply the presence of these actors that make an Australian WiFi, but *how* they come together that is important. I argued throughout the thesis, and specifically in Chapter Eight, that Air-Stream's backyard technologists' particular version of WiFi is homebrew high-tech. What this means is that members mod and make-do to make WiFi.

Mods are Air-Stream's unique approach to making-do, an Australian local style of adaptability and ingenuity borne of a unique constellation of taxing local actors, colonial heritage and appropriate tools and equipment. I have described how WiFi does not slot easily or naturally into suburbia and because it constantly breaks, needs fixing and adapting to an ever-shifting ecology, it fits with making-do. From this position I proposed that Australian's have a 'natural' propensity for WiFi and drew on Miller and Slater (2000) who argued that Trinidadian's think of the internet as Trinidadian. This thesis takes the view that an Australian version of WiFi presents an alternative way of considering the possibilities of development and potential of use to other places. This is because WiFi with its openness to tinkering and backyard installations fits in Australia the way the internet with its support of chatting and identity politic fitted in Trinidad. The implications of an Australian WiFi suggest the presence of alternate versions in other countries, thus raising the questions: What would British WiFi look like? How might French WiFi compare to Portuguese WiFi?

Modding involves putting things together in new ways and flattening assemblies of human and non-human actors into newly configured heterogeneous networks. This thesis is full of examples of mods and modding. It began with an example of Tim's 'ad-hoc' alarm system made from his mobile phone, laptop and the rooftop antenna (p.12). Both Dan's shed node (p.146) and Reg's tree node (p.119) are prime examples of how members enrol diverse assemblies of available materials, improvised methods and skill sets. Further still, Peter and Craig's meeting presentation shows mods in the installation of a new antenna in challenging and time constrained circumstances (p.143). Although planned in advance, mods reveal quick, ingenious and resourceful responses to deadlines imposed by daylight, the home-owner's schedule, work, school or family commitments. Further still, they enfold materials 'at-hand' and incorporate improvised methods. Mods are essential to experimentation. They emerge from a deep understanding of the properties of material, place and personal skills. Air-Stream's modding is a process of learning through trial and error. As a result, mistakes, things that break and failure are regular features of how members make WiFi and accounts for why members are not the least bit embarrassed or concerned about exposing their

mistakes. For instance, Dave candidly revealed his process of problem solving to raise his antenna (p.165). Exposing the many tangents and dead ends served to reveal his curiosity and innovative ingenuity to the rest of the group. In this way, members build on each other's problems, mistakes and experiments, which in turn deepen and strengthen their knowledge about WiFi in specific conditions as well as bonds in the group. In Chapter Five I argued that Air-Stream members delight in the unpredictability and instability of their network. In contrast, a stable and constant connection, such as most commercial ones in the context of Air-Stream would result in disconnection from a range of hands-on skills and abilities to modify and make-do. This is one answer to Green and Harvey's (1999) question about what is lost with constant connectivity.

The practice of modding and making-do mean that members are open to using these kinds of materials in new ways, thus challenging normative understandings and expectations of how a new digital technology is made. The skills involved in making-do are important for Air-Stream members. In contrast, in STS it is clear that only the strongest and most robust ideas survive the gruelling inscription process. If a graph or drawing fails to capture and persuade pivotal audiences then it does not progress any further along the 'assembly line' on its way into the public sphere (Latour and Woolgar 1979; Woolgar 1993; Latour 1998; Delamont and Atkinson 2001). Delamont and Atkinson (2001) show how science students were ill equipped to deal with the reality of process in science labs because they too believed the robust polished facts produced for public view. Inscriptions and conscriptions are not vehicles for vulnerable ideas, mistakes or diversionary tangents. There is no place for accidents or failure in this framework. Writing about Latour and Woolgar's (1979) concept of inscription, Law argues that:

> Their stories are full of talk about the vagueness of objects as they took (or failed to take) shape in the laboratory. They talk of the chosen few that made it through to the stable maturity of a perspectival 'closure' (2005:56).

What was clear from the onset was that Air-Stream members did not get anxious about things that looked like junk, did not fit, occasionally disappeared or failed to work. Members were unperturbed by connections that disappeared in the morning only to reappear by evening, or by environmental interruptions or even a more common, unknown and mysterious range of actors. Building a node into a tree for instance, provided a way to explore alternative ways to employ 'found' materials and new connections across the city (p.139). Rather than pre-empt a definitive response, the many examples of mods and modding reveal how members adapt to unfolding events and allow ambiguity to catalyse

new ideas and experiments. This approach is not messy. It has a distinct logic to it. As a result, members do not recognise mess in their visual representations of connectivity because it is enfolded in a larger practice that continually adapts to changing circumstances. Air-Stream's homebrew infrastructure dispels the 'one size fits all' leitmotif that characterises commercial systems. This flexible and responsive infrastructure adapts and adjusts to a wide range of instabilities. Even with the loss of significant points in the network it did not crash (p.155).

Compared to science lab or engineering office, any kind of non-hierarchical group set up outside an institution is bound to be messy. The difference lies in how this mess is recognised and used. As expected, Thomson's (2002, 2007) many books on Australian trade and shed culture reveal a lot of mess. The photos of his respondents' sheds typically reveal scattered tools, rusty car parts, tangled metal, old furniture, bike parts, oily rags, twisted coils of wire and piles of wood. Yet, upon reading his conversations with the owners, not once is the space, materials or any aspect of their working process described in terms of mess. Again, it is not part of their cultural understanding.

This thesis has also argued that WiFi is not just what a specific group of Australian's do, but what a specific group of Australian men do. The absence of women in the group serves to normalise the idea that WiFi is predominantly for men. This is despite the fact the group represents itself as a 'community' group and exhibit few of the traditional barriers to entry that inhibit access by women. Following Faulkner's (2000) example in engineering, this thesis explored what made WiFi 'stick' to men. The role of the barbeques and its masculine connotations along with associated references to colonial understandings of mateship and making-do gives shape to the gendering of WiFi technology. Despite its contemporary re-emergence, making-do retains a resolutely white and masculine identity. Similarly, field experiences confirmed Kleif and Faulkner's (2003) claim that tinkering is a male activity linked to masculinity. Despite this, I have described many women involved in the network who are essential to its success, yet are often hidden behind the scenes. Wives, sisters, aunts, female friends and girlfriends of members regularly helped source materials, host barbeques, paid for electricity and otherwise sustained male members. With the exception of Jan and Jane, however, women rarely attended meetings or other WiFi events, unless accompanying their partner or family member. This is not to say that only men make new digital technology in Australia. But for Air-Stream, it is clear the case that women play a supporting role.

This thesis therefore highlights an opportunity for further research to explicitly focus upon women backyard technologists. In the context of Air-Stream, it was not that women were not attracted to the network. This was shown by the fact that many accessed it once it was in their homes. It was just that they were not 'interested' in how this particular group chose to make it. Given the network is made visible and known through its representations, the absence of women in the representational culture that surrounds WiFi provides one explanation for their distance from the group. As outlined in Chapter Two (p.54), this thesis did not intend to explore the role of women in WiFi, nor did it attempt to ask, or indeed ask the question: Where are the women? Instead, given their overt absence, it became a subtext through which other actors and their actions were rendered all the more present. What these ethnographic ways of knowing suggest is the possibility that other ways of representing the making of WiFi might prove more attractive to women and result in their increased *visible* involvement and participation in the group.

This study of Air-Stream has clearly shown how the internet is not the only way people connect to one another. Air-Stream's 'other broadband' invites many alternate ideas of connectivity beyond that of a centralised hub of control provided and managed by a commercial distributor. In doing so, it reveals the Australian suburbia and backyard technologists as important producers of new technological innovation.

The productive possibility of mess in sociology: methodological implications

In addition to examining mess in substantive data, this thesis also poses a methodological intervention more broadly in the craft of sociology. Here, I am concerned with ways mess functions as a methodology – in particular its limitations and drawbacks as I experienced them in this ethnography of Air-Stream. The sociological discipline explores not only the mess of others, but also deals with mess itself. This study emerges at a point in sociological history in which mess is considered methodologically. In particular, ANT studies open up the possibility that systems and networks are less ordered than first thought and propose more fluid, flexible, unstable interpretations of how they operate (de Laet and Mol 2000; Mol 2002; Law 2004; Law and Singleton 2005). However, until Law's (2004) call for a reconsideration of mess, mess in sociological methodology was largely seen as something to overcome and tidy up (Hammersley and Atkinson 1995; Fetterman 1998; Atkinson et al 2001). Mess is always present in ethnographies and the challenge lies in understanding how it makes sense to members of a particular social group. The ethnographer is tasked with uncovering the logic of how members make meaning from mess. However, much like

scientists and engineers, sociologists are conventionally trained to work with and, ultimately, through mess. Mess has little presence in the final textual output.

Hine critiques this established approach: 'Our methodological instincts are to clean up complexity and tell straightforward linear stories, and thus we tend to exclude descriptions that are faithful to experiences of mess, ambivalence, elusiveness and multiplicity' (2007:12). Law argues that this desire to clean up actually contradicts our own understanding of the world and, in turn, limits the possibilities of other forms of knowing. Mess affords a new way to consider sociological methods that embrace 'impossible or barely possible, unthinkable or almost unthinkable' versions of reality (Law 2004:6). The opportunity to explore alternative objects of study and ways of representing them presents an exciting time for sociology. Yet, it is not easy. Writing about ever appearing versions of alcoholic liver disease, Law admits: 'Vicky and I were finding it impossible to map what was going on precisely because it was a mess' (2003:4). The fact that everything collapses into mess, both in field and in analysis, is challenging to an ethnographer tasked with making sense of mess. And there are few practical instructions for how to deal with it.

Mess was loomed large during my time with Air-Stream. One way I tried to respond and capture it in my thesis is through photos. Using photo collages I attempted to replicate the virtue of my many messy ethnographic experiences. Inspired by British artist David Hockney's 'joiners' (See Tusa, *no date*), my interpretation emerged in response to feeling that single photos unnecessarily restricted the boundaries of events in the context of my fieldwork. One image felt limiting. Yet, while one image could not fully capture an experience, lots of images promised more texture and busyness in which to explore a range of activity, interactions and actors (Fig. 49). I was also attracted to Hockney's joiners because, 'the centre of the collage seems to move' and 'the eye looking seems to slip, to be unable to 'fix' on anything' (Reinelt and Roach 1992:109). On one level they are multi-temporal and fragmented and they work because this is very much in keeping with the spirit of Air-Stream activity; the frenzy of demo's, the overlapping representations and the chaos of people moving around in meetings. I also regularly placed myself in images, thereby contributing myself to the mess.

Yet, on another level, they fail because they stabilise the experience. The dynamism is lost because mess is resolved. Mess is made coherent. Despite retaining its messy edges, scenes are flattened and bracketed. They are also reduced. Joiners do not fit well into printed arguments. I tried inserting them vertically to achieve a bigger size to appreciate the messy detail but turning the thesis from vertical to horizontal only served to interrupt the flow of

the argument[35]. I considered inserting horizontal foldouts into the text but according to University postgraduate submission regulations, this is strictly prohibited[36]. The fact that I took single photos during my ethnography and use them throughout the thesis, also serves to undermine my argument about the incapacity of individual photos to carry knowledge.

In retrospect, another solution might have involved asking Air-Stream members to take their own photos during these experiences and give them to me to piece together in some way, with my own sketches to fill the gaps, after the event. This would have produced a collaborative, messy, possibly overlapping and contradictory result, much in keeping with the arguments put forth in the chapter. Alternatively, like my respondents, I could have embraced a making-do approach and modded a much larger range of responses using materials at hand – a homebrew approach – along the way

Law's (2004) mess manifests itself in another part of my fieldwork experience. As I reported in Chapter Three, during my stay in Adelaide I became a member of a local freakbike club (p.70). Initially conceived as a cheap, convenient and enjoyable mode of transport in a quiet flat city, my bike unexpectedly became an entry point into a new group. For eight months, guided by members, I learnt to scavenge materials from discarded rubbish, dismantle, re-build, ride and cope with various 'mechanicals' that occurred in the process. I organised a group ride, contributed to the group blog, kept field notes for the duration of this period and took many photos. Building on Lauriers' (2008) insights about developing broader technical competencies to study technologists, I found these encounters with homebrew technologies who made-do with bicycles particularly insightful and engaging to my larger WiFi study. At the end of this (extra) fieldwork, I interviewed five members and gained informed consent to include this work in my thesis. I was tempted to include a chapter in the thesis about how engaging in making bikes provided insights into a strikingly different yet comparable backyard technology group. But it did not work. It was too messy. The fact it did not fit into my thesis serves to reinforce the problem of experiencing mess and keeping it alive.

[35] I have included select ethnographic 'joiners' printed on a larger scale in the back of this thesis.
[36] Incidentally, using sticky tape for anything is frowned upon – 'In no circumstances should 'Sellotape' or similar materials be used for any purpose' - University of London: Theses for Research Degrees Guidelines (Accessed 22.10.08, Available at: http://www.london.ac.uk)

Fig. 49. A series of single photos versus a joiner (personal images).

Making middlework public and keeping mess alive

Law advocates the potential and possibility of messiness on the basis that conventional sociological methods are 'materially restrictive' and serve to create realities that are 'independent, prior, singular, definite and passive', all of which mean they are separate to and distinct from researchers (2004:147). Although these restrictions have their place, he says we should embrace and draw from mess in order to realise other modes of description to unlock the potential for expressing different versions of the world. He challenges sociologists to radically re-imagine representations of knowledge, to be more experimental and open to new expressions of the world.

> What difference would it make if we were instead to apply the criteria that we usually apply to novels (or even more to poetry) to academic writing? (...) of course we would need to imagine representation in a new way. Poetry and novels wrestle with the materials of language to *make* things, things that are said to be imaginary. It is the making, the process of the effect of making, that is important. The textures along the way cannot be disassociated from whatever is being made, word by word, whereas academic volumes hasten to describe, to refer to, a reality that lies outside them (2004:9-10).

Put simply, what he is advocating is recognition of unconventional forms of knowledge and the production of alternate sociological representations (2004:148). However, he does not say how to do it. Although his writings are full of ways to recognise mess and uncertainty, they are silent on how to present mess and uncertainty back. Few sociologists *make* knowledge in anything other than text. Although participation and observation are central to ethnographic engagement, ultimate analysis involves translation of thick description into academic written prose. Even in the context of visual sociology, text dominates other representative forms (Chaplin 1994; Pink 2001; Knowles and Sweetman 2004). Pink, for instance writes, 'It might seem ironic, or even contradictory, that a text about visual research and representation should primarily be published in the form of a book that makes a fairly conventional use of written words and photographic images' (2001:176). She goes on to explain that this is because 'printed books are still the dominant medium for academic representation' (ibid). Another exception, however, is provided by Back (2004), who recounts an exhibition that brought together sociologists and 'subjects' of an urban photography project:

> It was a unique event – I could not imagine a similar equivalent in the context of sociological or anthropological proceedings. It is rare that research participants are present at sociology conferences where their lives are being discussed. Somehow the presence of 'subjects' made it impossible for their representations to be cast of caricature. The people and the images were allowed to be prosaic compounds of vice and virtue, they were allowed to be annoyingly human (2004:138).

This is what Law (2004) would term messy. It involved a gathering of things, not all of which were in the control of the researcher. Despite the weakness of my photo collages, what remained constant throughout my fieldwork was a desire to make public my own sociological mess, namely all the work that takes place in the middle, or what I have termed middlework. I drew inspiration from my respondents' practice of sharing the messy tangents and mistakes, haphazard improvised activities and mods in the process of making WiFi. I attempted to 'remain faithful to experiences of mess' (Hine 2007:12) and be 'annoyingly human' (Back 2004:138) by exposing my vulnerable ideas and random thoughts and seeking their responses and feedback in a number of ways.

My homebrew exhibition of my phd-in-progress took some of the ideas emerging on my blog, my field notebook and other writing into a new medium (Fig. 50). It was an experiment, as Back notes of the street photography project that preceded the exhibition, 'as a means to open up a space of exchange and engender a form of reciprocity between research subjects and observers' (2004:132).

The exhibition took place in January 2008 during one of return visits to Adelaide. It was constructed using materials 'at hand' and located in the context of the network, between the garage and fence of a suburban house in central Adelaide and involved a barbeque. Drawing on how Air-Stream members make their middlework public, this exhibition sought to reveal the making of sociology about the making of WiFi. It was open and messy. Respondents wandered through it during and after the barbeque and they took pieces they wanted home (photos, text and clothes pegs). Conversations were triggered by human, material and environment collisions brought about by bits of the exhibition escaping or getting tangled in the wind. There was no trajectory or guided viewing to shape individual experiences. Overall, the experience was significantly random, unfinished and enjoyable. In addition to my research blog, also outlined in Chapter Two, this example serves to illustrate how the process of carving out space where ideas are open and exploratory invites collaboration from respondents in the making of sociological knowledge.

These examples are intended to provide ways in which my thesis might be applied to further sociological study. The conclusion, as a whole, set out to develop and offer a theoretical and a methodological intervention into sociological knowledge. I propose that the small, mundane and ordinariness of backyard technologists offer new points into the STS of ICTs and methodological ways of approaching it.

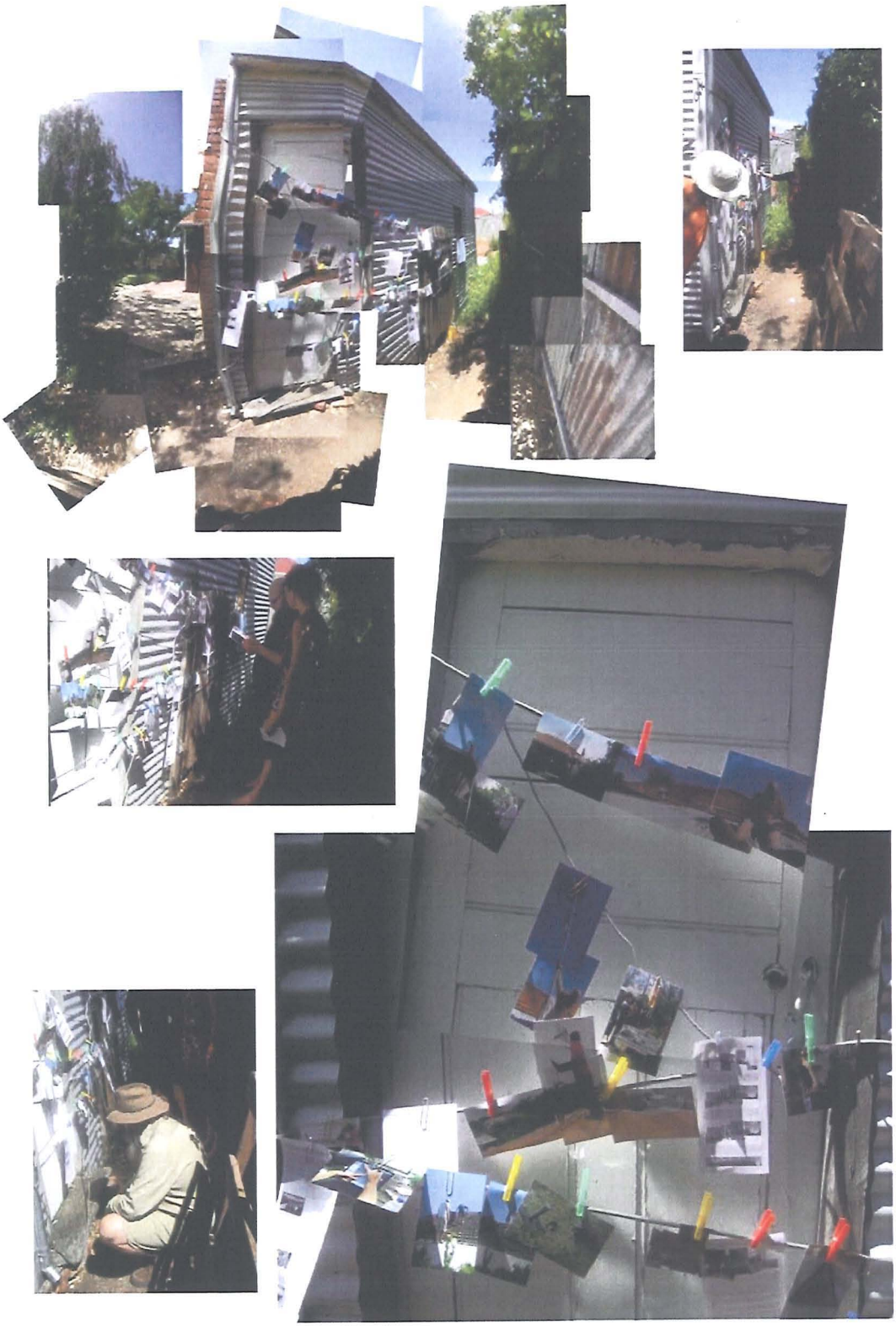


Fig. 50. A 'homebrew' exhibition of my PhD research (Personal images 20.01.07).

References.

ABS (Australian Bureau of Statistics). (2001) *Adelaide: A Social Atlas*, Report No. 2030.4, 11th January, Accessed 22.07.08, Available at: http://www.abs.gov.au

ABS (2003) *Household Use of Information Technology, Australia*, Report No. 8146.0, 9th October, Accessed 22.02.06, Available at:

ABS (2004) *Regional Statistics: South Australia*, Report No. 1362.4, 11th October, Accessed 10.02.06, Available at: http://www.abs.gov.au

ABS (2004b) *Year Book Australia,* Report No. 1301.0, 27th February, Accessed 10.04.06, Available at http://www.abs.gov.ac

ABS (2005) *Internet Activity,* March, Report No. 8153.0 Accessed 10.04.06, Available at: http://www.abs.gov.au

ABS (2005b) *Household Use of Information Technology, Australia, 2004-05,* Report No. 8146.0, 15th December, Accessed 10.02.06, Available at: http://www.abs.gov.au

ABS (2006) *Patterns of Internet Access in Australia,* Report No. 8146.0.55.001, Accessed 22.07.08, Available at: http://www.abs.gov.au

ABS (2006b) *Adelaide: A Social Atlas,* Report No. 2030.4, 17th March, Accessed 22.07.08, Available at: http://www.abs.gov.au

ABS (2007) The *ABS Internet Activity, Australia,* Report No. 8153.0, 29th November, Accessed 22.07.08, Available at http://www.abs.gov.au

ABS (2007b) *Population, Australian States and Territories*, Report No. 3239.0.55.001, Accessed 22.07.08, Available at: http://www.abs.gov.au

ABS (2008) *Geographic Distribution of the Population*, Report No. 1301.0, Year Book Australia 2008, 7th February, Accessed 22.07.08, Available at: http://www.abs.gov.au

ABS (2008b) *Internet Activity, Australia*, Report No. 8153.0, June, Accessed 22.07.08, Available at: http://www.abs.gov.au

ABS (2008c) *Australian Social Trends,* Report No. 4102.0, July, Accessed 12.08.08, Available at: http://www.abs.gov.au

ABS (2008d) Household Use of Information Technology, Australia, Report No. 8146.0, 18th December, Accessed 30.12.08, Available at: http://www.abs.gov.au

Ackrich, M. (1992) 'The De-Scription of Technical Objects', In W. Bijker and J. Law. (eds) *Shaping Technology, Building Society: Studies in Sociotechnical Change*. Cambridge, MA: MIT Press, pp. 205-224.

ACMA (Australian Bureau of Statistics Australian Communications and Media Authority). (2008) *Closed Environment Testing of ISP Level Internet Content Filters: Report to the Minister for Broadband, Communications and the Digital Economy*, June, Accessed 22.10.08, Available at: http://www.acma.gov.au

Agar, J., Green, S and Harvey, P. (2002) 'Cotton to Computers, From Industrial to Information Revolutions', In Woolgar, S. (ed) *Virtual Society? Technology, Cyperbole, Reality*, Oxford: Oxford University Press.

Air-Stream. *Adelaide Volunteer Community Wireless Network,* Accessed on various dates indicated in thesis, Available at: http://www.air-stream.org.au

Allen, M and J, Long. (2004) 'Domesticating the Internet: Content Regulation, Virtual Nation-Building and the Family', In G. Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 229-241.

ALP (Australian Labor Party). (2007) New *Directions for Communications: A Broadband Future for Australia - Building a National Broadband Network*, ALP, Canberra. Accessed 10.10.08, Available at: http://www.iia.net.au

Alpers, S. (1984) *The Art of Describing: Dutch Art in the Seventeenth Century*, London: Penguin Books.

ANBG (Australian National Botanic Gardens). (2004) *Mallee Plants: Surviving Harsh Conditions*, Discover Information Resources, Education Services, ACT.

Atkinson, P. (1990) *The Ethnographic Imagination; Textual Constructions of Reality*, London and New York: Routledge.

Atkinson, P., Coffey, A.J., Delamont, S., Lofland, J., and L.H Lofland. (eds) (2002) *Handbook of Ethnography*, London: Sage.

Back, L. (2004) 'Listening With Our Eyes: Portraiture as Urban Encounter', In C, Knowles and P, Sweetman. (eds) *Picturing the Social Landscape: Visual Methods and the Sociological Imagination,* London: Routledge

Back, L. (2007) *The Art of Listening,* Oxford and New York: Berg Publishers.

Back, L., Halliday, P., Knowles C., Wakeford N and A, Coffey. (2008) *Live Sociology: Practising Social Research with New Media*, Series of Research Workshops, Goldsmiths College, University of London, Accessed: 10.07.08, Available at: http:www.goldsmiths.ac.uk/livesociology/course-description.pdf and http://www.goldsmiths.ac.uk/livesociology

Ball, M. S and G, Smith. (1992) *Analysing Visual Data,* London: Sage Publications.

Balnaves, M. (2002) 'New Media and New Audiences', In Cunningham, S and Turner, G. (eds) *The Media and Communications in Australia,* Crows Nest: Allen and Unwin.

Banks, M. (2001) *Visual Methods in Social Research*. London: Sage.

Barron, N. (2004) 'You Are What They Post: Identity Construction on the Internet', Paper given at *Association of Internet Research (AoIR) Conference 5.0*, University Surrey, UK.

Barthes, R. (1964) *Elements of Semiology*, New York: Hill and Wang.

Barthes, R. (1999) 'Myth Today', In J. Evans and S. Hall. (eds) *Visual Culture: The Reader*, London: Sage.

Baum, S. W., Gellecum, Y.R and T, Yigitcanlar. (2004) *Wired Communities in the City: Sydney, Australia*, Australian Geographical Studies, June, 42 (2), pp. 175-192.

Baym, N. (2000) *Tune in, Log on: Soaps, Fandom and Online Community*, London: Sage.

BBC News (British Broadcasting News). (2003) *UN urges WiFi for all*, 27th June, Accessed 10.02.06, Available at: http://news.bbc.co.uk/2/hi/technology/3025734.stm

BBC News. (2004) *Wi-Fi Boom Prompts Hacking Fears*, 28th May, Accessed 27.11.05, Available at: http://news.bbc.co.uk/1/hi/wales/3753479.stm

BBC News. (2004b) *Surf the New While Surfing the Waves,* 18th June, Accessed 27.11.05, Available at: http://news.bbc.co.uk/1/hi/technology/3812357.stm

BBC News. (2005) *Google Unveils Blog Search Site*, 14th September, Accessed 10.04.06, Available at: http://news.bbc.co.uk/1/hi/technology/4244944.stm

BBC News. (2005a) *Rail Stations to be WiFi Enabled*, 10th May, Accessed 27.11.05, Available at: http://news.bbc.co.uk/1/hi/england/bristol/4533789.stm

BBC News. (2005b) *Wireless Broadband Goes to Church*, 31st May, Accessed 27.11.05, Available at: http://news.bbc.co.uk/1/hi/wales/south_east/4594989.stm

BBC News. (2005c) *Belfast Firms 'Ignore WiFi Risk'*, 24th March, Accessed: 27.11.05, Available at: http://news.bbc.co.uk/1/hi/northern_ireland/4378337.stm

BBC News. (2005d) *Mobile Phone Plan for Tube Users*, 22nd March, Accessed: 27.11.05, Available at: http://news.bbc.co.uk/1/hi/england/london/4373015.stm

BBC News. (2006) *Google Censors Itself for China,* 25th January, Accessed: 23.03.07, Available at: http://news.bbc.co.uk/1/hi/technology/4645596.stm

Becker, H. (1974) 'Photography and Sociology', *Studies in the Anthropology of Visual Communication*, 1, pp. 3-26, Accessed: 1.10.05, Available at: http://lucy.ukc.ac.uk/becker.html

Becker, H. (1982) *Art Worlds*, Berkeley: University of California Press.

Becker, H. (1998) 'Visual Sociology, Documentary Photography, and Photojournalism: It's (Almost) all a Matter of Context', In J. Prosser. (ed) *Image-Based Research*, London: Routledge.

Becker, H. (2003) 'Field Methods and Techniques: A Note on Interviewing Tactics', In N. Fielding. (ed) *Interviewing*, London: Sage, (3), pp. 45-48.

Becker, H and B. Geer. (2003) 'Participant Observation and Interviewing: A Comparison'. In N. Fielding. (ed) *Interviewing*. London: Sage, (4), pp. 294-311.

Bell, G. (2006) 'Satu Keluarga, Satu Komputer (One Home, One Computer): Cultural Accounts of ICTs in South and Southeast Asia', *Design Issues,* Spring 22 (2), pp: 35-55.

Bell, G. and P. Dourish. (2006) 'Back to the Shed: Gendered Visions of Technology and Domesticity', *Personal & Ubiquitous Computing: At Home with IT*, 11(5), pp. 373-381.

Benkler, Y. (2006) *The Wealth of Networks: How Social Production Transforms Markets and Freedom*, USA: Yale University Press.

Bijker, W. E. (1995) *Of Bicycles, Bakelites and Bulbs: Toward a Theory of Social Change*, Cambridge MA: MIT Press.

Bijker, W. E and J, Law. (1992) *Shaping Technology/ Building Society: Studies in Sociotechnical Change*, Cambridge MA: MIT Press.

Bina, M and G. M. Giaglis. (2005) *Emerging Issues in Researching Community-Based WLANS,* Journal of Computer Information Systems, Accessed 24.03.06, Available at: http://www.eltrun.gr/papers/2005_bina_giaglis.pdf.

Birmingham, J., Jack, R.I and D.N Jeans. (1979) *Australian Pioneer Technology: Sites and Relics: Towards an Industrial Archaeology of Australia*, Melbourne: Heinemann

Bollen, J., Kiernander, K and B, Parr. (2008) *Men at Play; Masculinities in Australian Theatres Since the 1950s*, Amsterdam and New York: Rodopi.

Bowker, G and S. L. Star. (1996) *How Things (Actor-Net)Work: Classification, Magic and the Ubiquity of Standards*, Available at: http://epl.scu.edu:16080/~gbowker/actnet.html

Bowker, G and S. L. Star. (1999) *Sorting Things Out: Classification and its Consequences,* Cambridge MA: MIT Press.

Brown, B, Green, N. and Harper, R. (eds) (2001) *Wireless World, Social and Interactional Aspects of the Mobile Age*, London: Springer Verlag.

Bruns, A and J, Jacobs. (eds) (2006) *Uses of Blogs*, New York: Peter Lang Publishing.

Bryman, A. (2004) *Social Research Methods*, Oxford: Oxford University Press.

Bucciarelli, L. (2002) *Designing Engineers,* Cambridge MA and London: MIT Press.

Burawoy, M. (2002) 'Teaching Participant Observation', In Atkinson, P., Coffey, A.J., Delamont, S., Lofland, J., and L.H Lofland. (eds) *Handbook of Ethnography*, London: Sage, pp. 291-300.

Burgess, J. (2006) 'Defining Vernacular Creativity', May, 10th, *Creativity Machine Weblog*, Accessed 5.05.07, Available at: http://www.creativitymachine.net

Burgess, J. (2006b) 'Blogging to Learn, Learning to Blog', In Bruns, A and J, Jacobs. (eds) (2006) *Uses of Blogs*, New York: Peter Lang Publishing, pp. 105-121.

Burgess, R. G. (1994) 'Some Role Problems in Field Research'. In R, Burgess and G, Field. (eds) *Field Research: Sourcebook and Field Manual*, London: Routledge, pp. 45-49.

Callon, M. (1986) 'Some Elements in a Sociology of Translation: Domestication of the Scallops and Fishermen of St Brieuc Bay', In J, Law. (ed) *Power, Action and Belief*, London: Routledge, pp.196-233.

Callon, M. (1986b) 'The Sociology of an Actor-Theory-Network: The Case of the Electric Vehicle', In Callon, M., Law, L and A, Rip. (eds) *Mapping the Dynamics of Science and Technology*, London: Macmillan Press.

Callon, M. (1997) 'Society in the Making: The Study of Technology as a Tool for Sociological Analysis'. In W. E. Bijker., T. P. Hughes and T. J. Pinch. (eds) *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology,* Cambridge, MA: MIT Press, pp.83-103.

Callon, M., Law, J and A, Rip. (eds) (1986) *Mapping the Dynamics of Science and Technology,* London: Macmillan Press.

Carr, P. (2004) 'The Terrifying Power of the Bloggers', *The Guardian Online*, 28th June, Accessed 10.10.08, Available at: http://www.guardian.co.uk

Cartwright, L. (1995) *Screening the Body; Tracing Medicine's Visual Culture,* Minneapolis: University of Minnesota Press.

Chabaud-Rychter, D. (1995) 'The Configuration of Domestic Practices in the Designing of Household Appliances', In R, Gill and K, Grint. (eds) *The Gender-Technology Relation: Contemporary Theory and Research*, London: Taylor & Francis, pp. 95-111.

Campbell, C. (2005) 'The Craft Consumer: Culture, Craft and Consumption in a Postmodern Society', *Journal of Consumer Culture*, 5 (1), pp. 23-42.

Chandler, D. (1998) *Personal Home Pages and the Construction of Identities on the Web*, Accessed 06.05.05, Available at: http://www.aber.ac.uk/

Chaplin, E. (1994) *Sociology and Visual Representation*, London and New York: Routledge.

Clark, M. (1978) *In Search of Henry Lawson*, Melbourne, Australian: Macmillan Press.

Clarke, R. (2004) 'The Emergence of the Internet in Australia', In G, Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 30-43.

Cockburn, C. (1983) Brothers: Male Dominance and Technological Change. London: Pluto Press.

Cockburn, C and M, Ormrod. (1994) *Gender and Technology in the Making*, London: Sage.

Code, L. (1988) 'Credibility: A Double Standard', In Code, L., Mullet, S and C, Overall (eds) (1988) *Feminist Perspectives: Philosophical Essays on Method and Moral,* Canada: University of Toronto Press, pp. 64-88.

Code, L. (1995) *Rhetorical Spaces: Essays on Gendered Locations*, UK: Routledge.

Code, L., Mullet, S and C, Overall. (eds) (1988) *Feminist Perspectives: Philosophical Essays on Method and Moral,* Canada: University of Toronto Press.

Coffey, A. (1999) *The Ethnographic Self; Fieldwork and the Representation of Identity*, London: Sage Publications.

Cohen, K. (2005) 'What Does the Photoblog Want?' *Media, Culture & Society*, 27 (6), pp. 883-901.

Cohen, K. (2006) 'A Welcome for Blogs', *Continuum: Journal of Media & Cultural Studies*, 20 (2), pp. 161-173.

Collier, J and M, Collier. (1986) *Visual Anthropology: Photography as a Research Method*, Albuquerque: University of New Mexico Press.

Collins, H. M and T. J. Pinch. (1982) *Frames of Meaning: The Social Construction of Extraordinary Science,* Henley-on-Thames: Routledge and Kegan Paul.

Collins, H. M and S, Yearley. (1992) 'Epistemological Chicken. Science as Practice and Culture', In A, Pickering. (ed) *From Science as Knowledge to Science as Practice,* Chicago: University of Chicago Press, pp. 301-336.

Consume.net. (2005) *London Volunteer Community Wireless Network*, Accessed 5.04.05, Available at: http://www.consume.net

Connor, A. (2005) 'Up in the Air', *Weblog Watch, BBC News*, Accessed 18.10.06, Available at: http://www.news.bbc.co.uk

Coonan, H. (2006) 'Information Technology: Transforming the Australian Economy', Speech given at the *15th World Congress on Information Technology*, Texas, USA, 2nd May, Accessed 3.05.06, Available at: http:///minister.dcita.gov.au/media speeches/information_technology_transforming_the_australian_economy

Cosgrove-Mather, B. (2004) 'Rickshaws Bring Internet Access: Wheels Of Hope Get Poor Indian Villagers Online', 16th August, *CBS News*, Accessed 10.10.06, Available at: http://www.cbsnews.com

CUWiN. (2007) *Champagne Urbana Wireless Network,* Accessed 15.07.07, Available at: http://www.cuwireless.net

Dant, T. (1999) *Material Culture in the Social World,* UK: Open University Press.

Davis, M. (2005) *Wi-Fi cities spark hotspot debate*, BBC Technology, 20th October, Accessed 2.03.06, Available at: http://news.bbc.co.uk

Day, J. (2005) 'Bus Shelters Face Makeover After Ad deal', *The Guardian Online*, 19th May, Accessed 9.09.05, Available at: http://www.guardian.co.uk

Diani, M. (1992) 'The Concept of Social Movements', *Sociological Review*, 40 (1), pp: 1-25.

Diani, M and R, Eyerman. (eds) (1992) *Studying Collective Action*, London: Sage.

Delamont, S and P, Atkinson. (2001) 'Doctoring Uncertainty: Mastering Craft Knowledge, *Social Studies of Science,* 31 (1), pp. 87-107.

Delamont, S., Atkinson, P and O, Parry. (2000) *The Doctoral Experience: Success and Failure in Graduate School*, London: Routledge.

de Certeau, M. (1984) *The Practice of Everyday Life*, California and London: University of California Press.

de Laet, M and A, Mol. (2000) 'The Zimbabwe Bush Pump: Mechanics of a Fluid Technology', *Social Studies of Science*, 30, pp. 225-263.

DICTA (Department for Communications Technology and the Arts). (2006) *Broadband Connect*, 30th March, Accessed: 3.05.04, Available at: http://www.dcita.gov.au/

DICTA. (2006b) *Telstra Shareholder History*, 31st March, Accessed 30.04.05, Available at: http://www.dcita.gov.au/

DICTA. (2008) *Chapter One: Broadband as Critical Infrastructure,* 5th February, Accessed: 26.09.08, Available at: http://www.archive.dcita.gov.au

Dikovitskaya, M. (2005) *Visual Culture: The Study of the Visual after the Cultural Turn*, Cambridge MA: MIT Press.

Denzin, N. K. (1997) *Interpretive Ethnography: Ethnographic Practices for the 21st Century*, London: Sage.

Denzin, N. K and Y. S, Lincoln. (eds) (2000) *Handbook of Qualitative Research, Second Edition,* London: Sage.

Docherty, D. (2003) 'The Wonders of a Wireless World', 8th December, *The Guardian Online,* Accessed 10.02.05, Available at: http://www.guardian.co.uk

Douglas, M. (1966) *Purity and Danger: An Analysis of the Concepts of Pollution and Taboo*, New York: Frederick. A. Praeger

Dovey, K. (1994) 'Dreams on Display: Suburban Ideology in the Model Home', In Ferber, S., Healy, C and C, McAuliffe. (eds) *Beasts of Suburbia: Reinterpreting Cultures in Australian Suburbs,* Melbourne, Victoria: Melbourne University Press, pp. 127-147.

Downey, G. L and Dumit, J. (1997) 'Locating and Intervening: an introduction', In G. L. Downey and J. Dumit. (eds) *Cyborgs & Citadels: Anthropological Interventions in Emerging Sciences and Technologies,* USA: School of American Research Press.

Duncan, M, Leigh, A, Madden, D, and P, Tynan (2004) *Imagining Australia: Ideas For Our Future*, Sydney: Allen & Unwin.

Duneier, M. (1992) *Slim's Table*, Chicago: University of Chicago Press.

Duneier, M. (1999) *Sidewalk*, New York: Farrar Straus and Giroux.

Dunne, A. (1999) *Hertzian Tales: Electronic Products, Aesthetic Experience and Critical Design*, London: RCA CRD Research Publications.

E3. *Perth Volunteer Community Wireless Network*, Accessed 22.08.07, Available at: http://www.e3.com.au

EFA (Electronic Frontiers Australia). (2008) *No Clean Feed campaign: Stop Internet Censorship in Australia*, Accessed 02.12.08, Available at: http://nocleanfeed.com

Eisenstein, E. (1979) *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-Modern Europe,* Volume II, London: Cambridge University Press.

Elder, C. (2007) *Being Australian: Narratives of National Identity*, Sydney: Allen & Unwin.

Ellis, R and C, Waterton. (2005) 'Caught between the Cartographic and the Ethnographic: The Whereabouts of Amateurs, Professionals and Nature in Knowing Biodiversity', Environmental Planning D, *Society & Space*, 23(5), pp. 673-693.

Emmison, M. (2000) 'The conceptualization and analysis of visual data', In D. Silverman (ed) *Qualitative Research: Theory, Method and Practice,* London: Sage, pp. 247-265.

Emmison, M and P, Smith. (2000) *Researching the Visual: Images, Objects, Contexts and Interactions in Social and Cultural Inquiry*, London: Sage Publications.

Emerson, R., Fretz, R and L, Shaw. (1995). *Writing Ethnographic Fieldnotes*, Chicago:. University of Chicago Press.

Emerson, R., Fretz, R and L, Shaw. (2002) 'Participant Observation and Fieldnotes', In Atkinson, P., Coffey, A.J., Delamont, S., Lofland, J., and L.H Lofland. (eds) *Handbook of Ethnography*. London: Sage, pp.352-368

English-Lueck, J. A. (2002) *Cultures @ Silicon Valley*, Stanford, CA: Stanford University Press.

English-Lueck, J. A. (2003) 'Number Eight Fencing Wire: New Zealand, Cultural Innovation and the Global Silicon Network', Adaptation of poster presented at the *2003 Annual Meeting of the American Anthropological Association*, 20th November, Chicago, IL, Accessed 15.04.07, Available at: http://www.sjsu.edu/depts/anthropology/

ESRC. (2007) *Towards A Social Science of Web. 2.0:* Press Release 5.10.07. Accessed 10.06.08, Available at: http://www.esrcsocietytoday.ac.uk

Evans, J and S, Hall. (eds) (1999) *Visual Culture: The Reader*, London: Sage.

Eyerman, R and A, Jamieson. (1991) *Social Movements: A Cognitive Approach,* Polity Press: Cambridge

Faulkner, W. (2000) 'The Power *and* the Pleasure? A Research Agenda for "Making Gender Stick" to Engineers', *Science, Technology & Human Values,* 25 (1), pp. 87-119.

Faulkner, W. (2000b) 'Dualisms, Hierarchies and Gender in Engineering', *Social Studies of Science*, 30 (5), pp. 759-792.

Faulkner, W. (2006) *Gadget Girls and Boys with their Toys: How to Attract and Keep More Women in Engineering,* Pamphlet, Accessed 10.1007, Available at: http://www.esrcsocietytoday.ac.uk

Faulkner, W. (2007) ''Nuts and Bolts and People': Gender-Troubled Engineering Identities', *Social Studies of Science*, 37 (3), pp. 331-356.

Faulkner, W and M, Lie. (2007) 'Gender in the Information Society: Strategies of Inclusion', *Gender Technology and Development,* 11 (2), pp. 157-177.

Fetterman, D. M. (1998) *Ethnography: Step by Step,* Second Edition, Applied Social Research Methods Series, (17), London: Sage.

Ferber, S., Healy, C and C, McAuliffe. (eds) (1994) *Beasts of Suburbia: Reinterpreting Cultures in Australian Suburbs,* Melbourne, Victoria: Melbourne University Press.

Fielding, N. (1993), 'Ethnography', In N, Gilbert. (ed) *Researching Social Life*, London: Sage, pp. 145-163.

Fielding, N. (2003) 'Editor's Introduction: Hearing the Social', In N, Fielding. (ed) *Interviewing*, London: Sage Publications, (1), pp.ix-xxii.

Fisk, J., Hodge, B and G, Turner (1987) *Myths of Oz: Analysing Australian Popular Culture*, Australia: Allen and Unwin.

Flew, T. (2008) *Creative Suburbia?* 14th August, Blog post, Accessed 22.10.08, Available at: http://www.terryflew.blogspot.com

Forlano, L. (2008) 'Anytime? Anywhere? Reframing Debates Around Municipal Wireless Networking', *The Journal of Community Informatics, Special Issue: Wireless Networking for Communities, Citizens and the Public Interest*, 4 (1), Accessed 12.10.08, Available at: http://ci-journal.net

Foucault, M. (1994) *The Order of Things: An Archaeology of Human Sciences*, New York and London: Vintage Press.

Foucault, M. (1997) *Discipline and Punishment: The Birth of the Prison*, New York and London:Vintage Press.

Foucault, M. (1998) 'Of Other Spaces', In N, Mirzoeff. (ed) *The Visual Culture Reader*, London: Routledge, pp. 237-244.

Fowler, B and F, Wilson. (2004) *Women Architects and Their Discontents*, Sage Publications, London: Thousand Oaks, 38 (1), pp: 101-119.

FreeNet Antennas. Accessed 1.02.06, Available at: http://www.freenet-antennas.com/

Fuentes-Bautista, M and N, Inagaki. (2005) 'Wi-Fi's Promise and Broadband Divides: Reconfiguring Public Internet Access in Austin, Texas', *The Telecommunications Policy and Research Conference*, Virginia, Accessed 22.10.05, Available at: http://www.utexas.edu/

Fyfe, G and J, Law. (1988) 'On the Invisibility of the Visual: editor's introduction', In G, Fyfe and J, Law. (eds) *Picturing Power: Visual Depiction and Social Relations*, London: Routledge, pp. 1-14.

Garfinkel, H. (1967) *Studies in Ethnomethodology*, NJ: Prentice Hall.

Geertz, C. (1973) 'Thick Description: Toward an Interpretative Theory of Culture', In C, Geertz, *The Interpretation of Cultures,* New York: Basic Books.

Geoscience Australia. (2008) *Land Areas of States and Territories*, Australian Government, Updated 16th October, Accessed 5.11.08, Available at: http://www.ga.gov.au

Gilmore, D. (2008) 'How 'Citizen Journalists' are Transforming the News', *New Scientist,* 15th March, Accessed 15.1.08, Available at: http://www.newscientist.com

Given, J. (2008) 'Australia's Broadband: How big a problem is it?' *Media International Australia*, 127, University of Queensland, pp. 6-10.

Glotz, G., Bertschi, S and C, Locke. (eds) (2005) *Thumb Culture; The Meaning of Mobile Phones for Society*, Bielefeld: Verlag.

Goffman, E. (1959) *The Presentation of Self in Everyday Life*, UK: Penguin Group.

Goffman, E. (1979) *Gender Advertising*, London: Macmillan Press.

Goggin, G. (2003) 'Digital Rainbows: Inventing the Internet in the Northern Rivers', In Wilson, H. (ed) *Belonging in the Rainbow Region*, Lismore: Southern Cross University Press, pp. 227-246

Goggin, G. (2004) 'Antipodean Internet: Placing Australian Networks', In G, Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press Press, pp. 2-12.

Goggin, G. (2004b) 'The Pegasus Story: A pioneering internet venture', In G, Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 44-54.

Goggin, G. (2007) 'An Australian Wireless Commons?' In G, Goggin and M, Gregg. (eds) *Wireless Cultures and Technologies,* Media International Australia: The University of Queensland, pp. 106-117.

Goggin, G and M, Gregg. (eds) (2007) *Wireless Cultures and Technologies,* Media International Australia: The University of Queensland.

Gottliebsen, R. (2007) 'Without Fast Broadband We'll Perish', *The Australian*, 26th April, Accessed 10.10.07, Available at: http://www.theaustralian.news.com.au

Green, N. (1999) 'Disrupting the Field: Virtual Reality Technologies and "Multi-sited" Ethnographic Methods', In P, Lyman and N, Wakeford. (eds) *Analysing Virtual Societies: New Directions in Methodology*, American Behavioural Scientist, 43 (3), pp. 409-421.

Green, S. (2000) *Opening Plenary,* Virtual Society? Get Real! 4-5th May, Hertfordshire, London: ESRC Programme: Virtual Society? The Social Science of Electronic Technologies.

Green, S and P. Harvey. (1999) 'Scaling Place and Networks: An Ethnography of ICT 'Innovation' in Manchester', Presented to *the Internet and Ethnography Conference* at Hull, 13-14th December, Accessed: 15.09.05, Available at: http://les.man.ac.uk/sa/Virtsoc/Scale.htm

Green, S., Harvey, P and H, Knox. (2005) 'Scales of Place and Networks: an Ethnography of the Imperative to Connect through Information and Communications Technologies', Current Anthropology 46(5), pp. 805-826.

Gregg, M. (2006) 'Feeling Ordinary: Blogging as Conversational Scholarship', *Continuum: Journal of Media & Cultural Studies*, 20 (2), pp. 147-160.

Gregg, M. (2007) 'Freedom to Work: The Impact of Wireless on Labour Politics', In G, Goggin and M, Gregg. (eds) (2007) *Wireless Cultures and Technologies,* Media International Australia: The University of Queensland, pp. 57-70.

Gregory, D and P, Sahre. (2003) *Hello World: A Life in Ham Radio,* Princeton: Princeton Architectural Press.

Grinyer, A. (2002) 'The Anonymity of Research Participants: Assumptions, Ethics and Practicalities', In *Social Research Update*, Spring, Issue 36, Guildford, UK: The Department of Sociology, University of Surrey, Accessed 12.10.08, Available at: http://www.sru.soc.surrey.ac.uk/SRY36.html

Halford, S and C, Knowles. (2005) 'More than Words: Some Reflections on Working Visually', *Sociological Research Online*, 10 (1), Accessed 24.04.06, Available at: http://www.socresonline.org.uk/

Hall, S. (1997) *Representation: Cultural Representations and Signifying Practices*, London: Sage.

Hall, T. (2007) *Where Have All the Gardens Gone? An Investigation into the Disappearance of Backyards in the Newer Australian Suburb,* Brisbane: Urban Research Program, Griffith University.

Hammersley, M and P, Atkinson. (1996) *Ethnography: Principles in Practice,* London: Routledge.

Hampton, K. N and B, Wellman. (1999) 'Netville on-line and off-line: Observing and surveying a wired suburb', In K, Lyman and Wakeford, N. (eds) *Analysing Virtual Societies: New Directions in Methodology*, American Behavioral Scientist, 43 (3), pp. 475-492.

Hampton, K. N and B, Wellman. (2000) Examining Community in the Digital Neighbourhood: Early Results from Canada's Wired Suburb'. In K, Isbister. (ed.) *Digital Cities: Technologies, Experiences, and Future Perspectives,* Germany: Springer-Verlag, pp. 194-208.

Hampton, K. N and B, Wellman. (2003) 'Neighboring in Netville: How the Internet Supports Community and Social Capital in a Wired Suburb', *City and Community*, 2 (4), pp. 277-311.

Hansell, S. (2008) 'WiMAX Gets Less-Than-Max Grades in Australia', *New York Times*, 24th March, Accessed 16.10.08, Available at: http://www.nytimes.com

Haraway, D. (1991) *Simians, Cyborgs and Women: The Reinvention of Nature*, New York: Routledge.

Haraway, D. (1992) 'The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others', In L, Grossberg, Nelson, C and P. A. Treichler. (eds) *Cultural Studies*, New York: Routledge, pp. 295-337.

Haraway, D. (1997) *Modest Witness@Second Millenium. FemaleMan Meets OncoMouse: Feminism and Technoscience*, New York and London: Routledge.

Haraway, D. (2004) 'Situated Knowledges: The Science Question in Feminist and the Privilege of Partial Perspective', In S, Harding. (ed) *Feminist Standpoint Theory Reader*, New York: Routledge, pp. 81-102.

Harding, S. (1987) *Feminism and Methodology,* Indiana: Indiana University Press.

Harding, S. (1991) *Whose Science? Whose Knowledge? Thinking from Women's Lives*, Open University Press.

Harding, S. (ed) (2004) *Feminist Standpoint Theory Reader*, New York: Routledge.

Haring, K. (2007) *Ham Radio's Technical Culture*, Cambridge, MA and London, England: MIT Press.

Harper, D. (1992) *Working Knowledge: Skills and Community in a Small Shop*, Oxford: University of California Press.

Harper (2000) 'Reimaging Visual Methods', In Y. S. Lincoln (ed) *Handbook of Qualitative Research*, Second Edition, London: Sage.

Harris, M., Atkinson, P., Coffey, A., and S., Delamont. (2003) *Key Themes in Qualitative Research: Continuities and Changes*, London: Rowman Altamira.

Harrison, B. (1996) 'Every Picture 'Tells a Story': Uses of the Visual in Sociological Research', In E, Lyon and J, Busfield. (eds) *Methodological Imaginaries*, London: Macmillan Press, pp. 75-94.

Hartley, J. (1999) *Uses of Television*, London: Routledge.

Harvey, D. (1989) *The Urban Experience,* Oxford: Basic Blackwell Ltd.

Hawkins, G. (2005) *The Ethics of Waste*, Oxford: Roman and Littlefield Publishers Inc.

Haythornthwaite, C and B, Wellman. (eds) (2002) *The Internet in Everyday Life*, The Information Age Series, MA: Blackwell Publishers.

Heath, C and P, Luff (1995) 'Explicating Face-to-Face Interaction', In N, Gilbert. (ed) *Researching Social Life*, London: Sage, pp. 36-326.

Heath, D. (1997) 'Bodies, Antibodies, and modest Interventions', In G, Lee Downey and J, Dumit. (eds) *Cyborgs & Citadels; Anthropological Interventions in Emerging Sciences and Technologies,* New Mexico: School of American Research Press, pp. 67-82.

Heath, D. (2000) 'Biocultural Informatics: Doing Anthropology of Genetics In Vivo and In Silico', Presentation at *Virtual Society? Get Real!* 4-5th May, Saïd Business School: Hertfordshire, UK, *Accessed* Available at: http://www.virtualsociety.sbs.ox.uk

Health, D., Ley. B., Koch, E and M, Montoya. (1999) 'Nodes and Queries; Linking Location in Networked Fields of Inquiry', In P, Lyman and N, Wakeford. (eds) *Analysing Virtual Societies: New Directions in Methodology*, American Behavioural Scientist 43 (3), pp. 450-463.

Heath, S and E, Cleaver. (2004) 'Picturing the Social Landscape: Visual Methods and the Sociological Imagination', In C. Knowles and P. Sweetman. (eds) *Picturing the Social Landscape: Visual Methods and the Sociological Imagination*, London and New York: Routledge, pp. 65-78.

Helmreich, S. (1998) *Silicon Second Nature*, Berkley: University of California Press.

Henderson, H. (1991) 'Flexible Sketches and Inflexible Data Bases: Visual Communication, Conscription Devices and Boundary Objects in Design Engineering', *Science, Technology, & Human Values*, 16 (4), pp. 448-473.

Henderson, K. (1999) *On Line and On Paper: Visual Representations, Visual Culture, and Computer Graphics in Design Engineering*, Cambridge, MA: MIT Press.

Hess, D. (2002) 'Ethnography and the Development of Science and Technology Studies', In Atkinson, P., Coffey, A.J., Delamont, S., Lofland, J., and L.H Lofland. (eds) *HandBook of Ethnography*, London: Sage, pp. 234-244.

Heyl, B.S. (2002) 'Ethnographic interviewing', In: P. Atkinson, A. Coffey, S. Delamont, J. Lofland and L. Lofland, (eds) *Handbook of Ethnography*, London: Sage.

Hine, C. (2000) *Virtual Ethnography,* Thousand Oaks, CA, London and New Delhi: Sage Publications.

Hine, C. (2007) 'Multi-sited Ethnography as a Middle range Methodology for Contemporary STS, *Science, Technology & Human Values*, 32 (6), pp. 652-671.

Hjorth, L. (2005) *Snapshots, Bilingual Catalogue with Essays (Korean and English)*. Copy provided by author.

Hjorth, L. (2007) *Waiting for Immediacy Catalogue*, Seoul: Yonsei University.

Hodkinson, P. (2002) *Goth: Identity, Style and Subculture*, New York: Berg.

Hogan, J. (2006) 'Telcos in Pact to Boost Broadband Speeds', *Sydney Morning Herald Online*, 21st April, Accessed 21.04.06, Available at: http://www.smh.com.au/

Ile Sans Fil. (2007) *Montreal Volunteer Community Wireless Network*, Accessed 18.08.07, Available at: http://www.*Iilesansfil*.org

INCITE (Incubator for Critical Inquiry into Technology and Ethnography). Research Lab website and blog, Available at: http://www.studioincite.com

Ingold, T and L, Vergunst. (eds) (2008) *Ways of Walking: Ethnography and Practice on Foot,* Hampshire, England: Ashgate.

Instructables. (2007) *Make, How, Do and DIY*, Accessed 10.10.07, Available at: http://www.instructables.com

Intel. (2008) *Moore's Law Made Real by Intel Innovation*, Accessed 22.11.08, Available: http://www.intel.com/technology/mooreslaw/index.htm

Ito, M. (2005) 'Otaku Media Literacy', In, *A Global Imperative, The Report of the 21st Century Literary Summit, National Media Consortium,* Accessed 10.10.08, Available at: http://www.itofisher.com

Ito, M. (2005b) 'Mobile Phones, Japanese Youth, and the Replacement of Social Contact', In R, Ling and P. P. Pedersen. (eds) *The Mobile Connection: The Cell Phone's Impact on Society*, London: Springer-Verlag, pp.131-148

Ito, M. (2006) *Imagining the Future of Amateur Cultural Production*, Blog post 28th February, Accessed 29.03.06, Available at: http://www.itofisher.com

Ito, M. (2006b) 'Technologies of the Childhood Imagination: Yugioh, Media Mixes, and Everyday Cultural Production', In J, Karaganis and N, Jeremijenko. (eds) *Structures of Participation in Digital Culture*, USA: Duke University Press.

Ito, M. (2008) *Amateur Cultural Production and Peer-to-Peer Learning*, A paper for the 2008 annual meeting of the American Educational Research Association, Accessed 10.06.08, Available at: http://www.itofisher.com

Ito, M., Okabe, D and M. Matsua. (eds) (2005) *Personal, Portable, Pedestrian: Mobile*

Phones in Japanese Life, Cambridge: MIT Press.

Jackson, P. (1989) *Maps of Meaning: An Introduction to Cultural Geography*, London: Unwin Hyman.

Jackson, S. (2006) 'Sacred Objects – Australian Design and National Celebrations', *Journal of Design History*, 19 (3), pp. 249-255.

James, G. (2003) *Bridging the Global Digital Divide*, UK: Edward Elgar Publishing.

Jenkins, H. (2006) *Convergence Culture*, New York: New York University Press.

Jenks, C. (1995) *Visual Culture*, London: Routledge.

Jiwire. (2006) *Worldwide Wi-Fi Hotspots Hits the 100,000 Mark*, Accessed: 10.03.06, Available at: http://www.jiwire.com/press-100k-hotspots.htm

Jiwire. (2006b) *2,170 Wi-Fi locations in Australia*, Accessed 10.03.06, Available at: http://www.jwire.com/browse-hotspot-australia-au.htm

Jiwire. (2008) *WiFi Finder*, Accessed 20.07.08, Available at: http://www.jiwire.com

Johnson, C. (2008) 'Kevin Rudd and the Labor Tradition: Economy, Technology and Social Diversity', Accepted paper for *The Political Studies Association Conference*, 6 – 9th July, Brisbane, Australia: Hilton Hotel.

Johnson, L. C. (1994) *Suburban Dreaming: An Interdisciplinary Approach to Australian Cities*, Sydney: University of New South Wales Press.

Johnson, M. (2005) 'Wireless is the Word for 2005', *Boston.com Business*, 10th October, Accessed 10.04.06, Available at: http://www.boston.com

Johnson, B. (2006) 'Ignore Bloggers at your Peril, Say Researchers', *The Guardian Online*, 18th April, Accessed 18.04.06, Available at: http://www.technology.guardian.co.uk

Johnston, F. (2008) 'Meet the Mothers of Invention', *The Guardian Online*, 1st February, Accessed 10.10.08, Available at http://www.guardian.co.uk

Jones, A. (2003) *The Feminism and Visual Culture Reader*, London: Routledge.

Jordan, T. (2002) *Activism! Direct Action, Hacktivism and the Future of Society*, Reaktion Books.

Journal of Community Informatics. Accessed 5.10.08, Accessed at: http://ci-journal.net/index.php/ciej/article/view/234/193

Joyce, Z. (2007) 'Spectrumspace: The Space of Wirelessness', In G, Goggin and M, Gregg. (eds) *Wireless Cultures and Technologies*, Media International Australia: The University of Queensland, pp. 83-93.

Judge, P. (2005) 'Brighton Rocks', *The Guardian Online*, 16th June, Accessed 27.10.05, Available at: http://society.guardian.co.uk

Jungnickel, K. (2003) *73 Urban Journeys*, Available at: http://www.73urbanjourneys.com

Jungnickel, K. (2006) *Making WiFi: Research Notes from an Ethnography of Volunteer Community Wireless Network in Australia*, Research weblog, Available at: http://www.studioincite.com/makingwifi

Jungnickel, K. (2006b) 'Hacking the Home: Technological Tantrums and Wireless Workarounds in Domestic Culture', Paper presented at *Wireless Cultures and Technologies workshop*, 2nd December, Sydney, Australia: University of Sydney.

Jungnickel, K. (2008) 'Disorderly Design: The Role of Mess in the Making of WiFi', Paper presented at *(4S) Society for Social Studies of Science, Acting with Science, Technology*

and Medicine, 2008 Annual Meeting, 23rd August, The Netherlands: University of Rotterdam.

Jungnickel, K and G, Bell. (2008) 'Home is Where the Hub is? Domestic Culture and Wireless Infrastructures in Australian Homes', In M, Foth. (ed) *Urban Informatics: Community Integration & Implementation*, Information Science Reference, Hershey, PA: IGI Global.

Katz, J and M. Aakhus. (2002) *Perpetual Contact: Mobile Communication, Private Talk, Public Performance*, Cambridge: Cambridge University Press.

Keen, A. (2007) *The Cult of the Amateur: How Today's Internet is Killing Our Culture and Assaulting our Economy*, London: Nicholas Brealey Publishing.

Kidman, A. (2006) 'What's Hot in What Spot?' *Australian IT*, 21st March, Accessed 20.04.06, Available at: http://australianit.news.com.au

Kiss, J. (2006) 'Spread of online movie clips shows YouTube's influence', *The Guardian Online*, 18th December, Accessed 10.10.08, Available at: http://www.gardian.co.uk

Kleif, T and W, Faulkner. (2003) '"I'm no Athlete [but] I can Make This Thing Dance!" – Men's Pleasures in Technology', *Science, Technology & Human Values*, 28 (20), pp. 296-325.

Kluth, A. (2008) 'The Mobile Future: Like the Advent of the Car, New Communications Technologies Promise to Change Society in Ways We Are Only Just Beginning to Understand', *The Guardian Online*, 17th Aril, Accessed 14.11.07, Available at: http://www.guardian.co.uk

Knorr Cetina, K. (1981) *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*, Oxford: Pergamon Press.

Knorr Cetina, K. (1999) *Epistemic Cultures: How the Sciences Make Knowledge*, London: Harvard University Press.

Knorr Cetina, K., Schatzki, T.R and E, Von Savigny. (eds) (2001) *The Practice Turn in Contemporary Theory*, London: Routledge.

Knowles, C. (2000) *Bedlam on the Streets*, London: Routledge.

Knowles, C and P, Sweetman. (eds) (2004) *Picturing the Social Landscape: Visual Methods and the Sociological Imagination*, London: Routledge.

Koprowski, G. J. (2004) 'Wireless World: City Wi-Fi Networks Growing', *United Press International (UPI)*, 11th December, Accessed 4.10.05, Available at: http://www.upi.com

Kotamraju, N. P. (1999) 'The Birth of Web Site Design Skills', In P, Lyman and N, Wakeford. (eds) *Analysing Virtual Societies: New Directions in Methodology*, American Behavioural Scientist, 43 (3), pp. 377-391.

Kuhn, T. S. (1970) *The Structure of Scientific Revolutions*, Chicago: Chicago University Press.

Lather, P. (2003) 'Feminist Perspectives on Empowering Research Methodologies', In N. Fielding. (ed) *Interviewing*, London: Routledge, pp. 149-167.

Latour, B. (1986) 'Visualization and Cognition: Thinking with Eyes and Hands'. *Knowledge and Society*, 6, pp. 1-40.

Latour, B. (1987) *Science in Action: How to Follow Scientists and Engineers Through Society*, Massachusetts: Harvard University Press.

Latour, B. (1988) 'Opening One Eye While Closing the Other: A Note on Some Religious Paintings', In G. Fyfe and J. Law. (eds) *Picturing Power: Visual Depiction and Social Relations,* London: Routledge, pp. 15-38.

Latour, B. (1988b) *The Pasteurization of France*, Cambridge MA: Harvard University Press.

Latour, B. (1990) 'Drawing Things Together', In M, Lynch and 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 and J, Law. (eds) *Shaping Technology/Building Society: Studies in Sociotechnical Change,* Cambridge, MA: MIT Press.

Latour, B. (1996) *Aramis, or the Love of Technology*, Cambridge, MA: MIT Press.

Latour, B. (1998) *Pandora's Hope: Essays on the Reality of Science Studies,* Cambridge, MA: Harvard University Press.

Latour, B. (1999) 'On Recalling ANT', In J, Law and J, Hassard. (eds) *Actor Network Theory and After,* Oxford: Blackwell Publishers, pp. 15-25.

Latour, B. (2004) 'Scientific Objects and Legal Objectivity', In A, Pottage and M, Mundy. (eds) *Law, Anthropology and the Constitution of the Social*, Cambridge: University Press, pp. 73-114.

Latour, B. (2005) *Reassembling the Social; An Introduction to Actor-Network-Theory.* Oxford: Oxford University Press.

Latour, B and S. Woolgar. (1979) *Laboratory Life, The Social Construction of Scientific Facts*, London: Sage.

Laurier, E. (1999) W*hy People Say Where They Are During Mobile Phone Calls*, Accessed: 04.04.05, Available at: http://www.geog.gla.ac.uk

Laurier, E. (2001) 'The Region as a Socio-Technical Accomplishment', In B, Brown., N, Green and R. Harper. (eds) *Wireless World: Social and Interactional Aspects of the Mobile Age*, UK: Springer-Verlag, pp. 46-60.

Laurier, E. (2008) *Assembling the Line: Amateur and Professional Work, Skills and Practice in Digital Video Editing*, Edinburgh University, Accessed 20.07.08, Available at: http://homepage.mac.com/eric.laurier/Assembling/index.html

Lave, J. (1988) *Cognition in Practice: Mind, Mathematics, and Culture in Everyday Life,* Cambridge: University Press.

Law, J. (ed) (1986) *Power, Action and Belief: A Sociology of Knowledge*?, London: Routledge.

Law, J. (1986a) 'Laboratories and Texts', In M. Callon., J, Law and A, Rip. (eds) *Mapping the Dynamics of Science and Technology,* London: Macmillan Press, pp. 35-50.

Law, J. (1986b) 'On the Methods of Long Distance Control: Vessels, Navigations, and the Portuguese Route to India', In J, Law. (ed) *Power, Action and Belief: A New Sociology of Knowledge? Sociological Review, Monograph 32,* Henly: Routledge, pp. 234-263.

Law, J. (1994) *Organizing Modernity*, Oxford: Blackwell.

Law, J. (2003) *Making a Mess with Method*, Centre for Science Studies, Lancaster University, Lancaster, Accessed 10.10.05, Available at: http://www.comp.lancs.ac.uk

Law, J. (2004) *After Method: Mess in Social Science Research*, UK: Routledge.

Law, J. and M. Callon (1988) 'Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technical Change' *Social Problems*, 35, pp. 284-297.

Law, J and J. Hassard. (1999) *Actor Network Theory and After*, Oxford: Blackwell Publishers.

Law, J and M, Lynch. (1990) 'Lists, Field Guides, and the Descriptive Organization of Seeing: Birdwatching as an Exemplary Observational Activity', In M, Lynch and S, Woolgar. (eds) *Representation in Scientific Practice*, Cambridge MA: MIT Press, pp. 267-299.

Law, J and A, Mol. (1995) 'Notes on Materiality and Sociality', *Sociological Review,* 43(2), pp. 274-294.

Law, J and A, Mol. (2001) *Situating Technoscience: An Inquiry into Spatialities,* Centre for Science Studies, Lancaster University, Lancaster, Accessed 10.10.05, Available at: http://www.comp.lancs.ac.uk

Law, J and A, Mol. (eds) (2003) *Complexities: Social Studies of Knowledge Practices,* Durham, NC: Duke University Press.

Law, J and A, Rip (1986) Mapping the dynamics of science and technology: sociology of science in the real world, UK: Sheridan House Inc

Law, J and V, Singleton. (2001) 'Performing Technology's Stories; On Social Constructivism, Performance and Performativity', *Society for the History of Technology and Culture*, 41 (4), pp. 765-775.

Law, J and V, Singleton. (2003) 'Allegory and Others', In Nicolini, D., Gherardi, S and D, Yanow. (eds) *Knowing in Organisations: A Practice Based Account*, New York: M. E. Sharp, pp. 225-254.

Law, J and V, Singleton. (2005) 'Object Lessons', *Organisation*, 12 (3), pp. 331-355.

Law, J and J, Whittaker. (1988) 'On the Art of Representation: Notes on the Politics of Visualisation', In G. Fyfe and J. Law. (eds) *Picturing Power: Visual Depiction and Social Relations,* London: Routledge.

Law, J and R, Williams. (1982) 'Putting the Facts Together: A Study of Scientific Persuasion', *Social Studies of Science,* 12 (4), pp. 535-538.

Leadbetter, C and P, Miller. (2004). *The Pro-Am Revolution,* London:Demos

Leadbetter, C. (2008) *We-Think: The Power of Mass Creativity* London: Profile Books.

Lennon, K and M, Whitford. (eds) (1994) *Knowing the Difference: Feminist Perspectives in Epistemology*, London and New York: Routledge

Lessig, L. (2004) 'Free Culture: How Big Media Uses Technology and the Law to Lock Down Culture and Control Creativity', *The Penguin Press*, Accessed 10.02.06, Available at: http://www.free-culture.cc/

Levis-Strauss, C. (1962) *The Savage Mind: Nature of Human Society*, Chicago: University of Chicago Press.

Libbenga, J. (2003) 'Pocket Wi-Fi sniffers End Missing Hotspot Misery', *The Register Online*, 18th September, Accessed 12.10.05, Available at: http://wwtheregister.co.uk

Ling, R and P.P, Pedersen. (eds) (2005) *The Mobile Connection: The Cell Phone's Impact on Society*, London: Springer-Verlag.

Linn, R. (2006) *Those Turbulent Years: A History of the City of Adelaide, 1929-1979,* Adelaide, South Australia: Adelaide City Council.

Lofland, J and L, Lofland. (1984) *Analyzing Social Settings*, California: Wadsworth Inc.

Lohan, M and W, Faulkner. (2004) 'Masculinities and Technologies; Some Introductory Remarks', *Men and Masculinities*, 6 (4), pp. 319-329.

Lucas, R. (1994) 'Round the Block: Back to the suburb in Return Home', In Ferber, S., Healy, C and C, McAuliffe. (eds) *Beasts of Suburbia: Reinterpreting Cultures in Australian Suburbs,* Melbourne, Victoria: Melbourne University Press, pp. 111-126.

Lyman, P and N, Wakeford. (eds) (1999) *Analysing Virtual Societies: New Directions in Methodology*, American Behavioural Scientist, 43 (3), pp. 409-421.

Lynch, G. (2008) 'Australian WiMAX pioneer trashes technology as 'miserable failure'', *ComsDay: Your Source for Telecom News and Analysis in Australia and the Asia-Pacific,* 20th March, Accessed 10.06.08, Available at: http://www.comsday.com

Lynch, M. (1985) *Art and Artifact in Laboratory Science: A Study of Shop Work and Shop Talk in a Research Laboratory,* London: Routledge and Kegan Paul.

Lynch, M and S, Woolgar. (eds) (1990) *Representation in Scientific Practice,* Cambridge, MA: MIT Press.

MacDougall, D. (1997) 'The Visual in Anthropology', In M, Banks and H, Morphy. (eds) *Rethinking Visual Anthropology,* London and New Haven: Yale University Press, pp. 276-95.

MacDougall, D. (1998) 'Transcultural Cinema', In D, MacDougall. (ed) *Visual Anthropology and the Ways of Knowing*, NJ: Princeton University Press.

McGrath, C. (2005) 'Coonan Confident of Improved Telstra Services After Sale', *DCITA,* Accessed 23.02.03, Available at: http://www.minister.dcita.gov.au

MacKay, H. (2008) 'Suburbia, Understanding Australia - Program 5', Interviewed by Sue Slamen, Radio Australia, *Australian Broadcasting Corporation,* Accessed 10.09.08, Available at: http://www.radioaustralia.net.au

Mackenzie, A. (2005) 'From Cafe to Parkbench: WiFi and Technological Overflows in the City', In M. Sheller (ed) *Technological Mobilities*, London and New York: Routledge.

Mackenzie, A. (2005b) 'Untangling the Unwired: The Cultural Implications of Wireless (Wi-Fi) Infrastructures', *Space and Culture,* 8 (3), pp. 269-285.

Mackenzie, A. (2007) 'Wireless Networks and the Problems of Over-Connectedness', In G, Goggin and M, Gregg. (eds) (2007) *Wireless Cultures and Technologies,* Media International Australia: The University of Queensland, pp. 94-105.

MacKenzie, D and J. Wajcman. (eds) (1999) *The Social Shaping of Technology,* Buckingham: Open University Press.

MacMahon, B and M, Dupain. (2001) *The Architecture of East Australia, An Architectural History in 432 Individual Presentations*, Stuttgart: Edition Axel Menges.

Maddison, S and S, Scalmer. (2006) *Activist Wisdom: Practical Knowledge and Creative Tension in Social Movements*, Sydney: University of New South Wales Press.

Makezine. *MAKE: Technology On Your Own Time*, Accessed 10.10.07, Available at: http://www.makezine.com

Malinowski, B. (1984) *Argonauts of the Western Pacific*, Waveland Press.

Marcus, G. E. (1998) *Ethnography Through Thick and Thin*, New Jersey: Princeton University Press.

Marks, K. (2004) 'Aussies Mourn Loss of Backyard to Urban Sprawl', *The Independent,* 25th July, Accessed 06.06.08, Available at: http://www.independent.co.uk

Marks, P. (2006) 'Cities Race to Reap the Rewards of Wireless Net for All', 28th March, *New Scientist,* Accessed 27.09.06, Available at: http://www.newscientist.com

Martin, E. (1994) *Flexible Bodies: The Role of Immunity in American Culture from the Days of Polio to the Age of AIDS*, Boston: Beacon Press.

Martin, E. (1996) 'Citadels, Rhizomes and String Figures', In B, Aronowitz, B, Martinsons, and M, Menser. (eds) *Technoscience and Cyber Culture,* New York: Routledge, pp. 97-109.

Martin, E. (2000) 'Flexible Bodies' Science and a New Culture of Health in the US', In S, Johnson Williams., J, Gabe and M, Calnan. (eds) *Health, Medicine and Society*, Routledge, pp. 123-145.

Martin, F and H, Wilson. (2002) 'Beyond the ABC's Backyard: Radio, the Web and Australian Regional Space', *Convergence: The International Journal of Research into New Media Technologies,* 8 (1), pp. 43-61.

Marvin, C. (1988) *When Old Technologies Were New; Thinking about Electric Communication in the Late Nineteenth Century*, Oxford: Oxford University Press.

Massey, D. (1994) *Space, Place and Gender*, USA: University of Minnesota Press.

Mason, J. (2002) *Qualitative Researching*, London: Sage Publications.

McIlwee, J, and J. G, Robinson. (1992) *Women in Engineering: Gender, Power and Workplace Culture,* Albany: State University of New York Press.

McKay, G. (ed) (1998) *DIY Culture: Party & Protest in Nineties Britain*, London and New York: Verso.

MacKay, H. (2008) 'Suburbia, Understanding Australia - Program 5', Interviewed by Sue Slamen, Radio Australia, *Australian Broadcasting Corporation,* Accessed 10.09.08, Available at: http://www.radioaustralia.net.au

McQuire, S. (1997) *Crossing the Digital Threshold,* Queensland: Australian Key Centre for Cultural and Media Policy.

Mead, M. (1975) 'Visual Anthropology in a Discipline of Words', In P. Hockings. (ed) *Principles of Visual Anthropology,* Paris: The Hague, Mouton Publishers, pp. 3-10.

Meikle, G. (2004) 'Networks of Influence: Internet activism in Australia and beyond', In Goggin, G. (ed) (2004) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 73-87.

Melbourne Wireless. (2006) Accessed 1.04.06, Available at: http://melbourne.wireless.org.au

Mellström, U. (2002) 'Patriarchal Machines and Masculine Embodiment', *Science, Technology & Human Values,* 27 (4), pp. 460-478.

Mellström, U. (2003) *Masculinity, Power and Technology; A Malaysian Ethnography*, Ashgate Publishing.

Mellström, U. (2004) 'Machines and Masculine Subjectivity: Technology as an Integral Part of Men's Life Experiences', *Men and Masculinities,* (6) 4, pp. 368-382.

Melucci, A. (1989) *Nomads of the Present: Social Movements, Culture and Individual Needs in Contemporary Society,* London: Hutchinson Radius.

Melucci, A. (1996) *Challenging the Codes: Collective Action in the Information Age*, Cambridge: Cambridge University Press.

Meredyth, M., Hopkins, L., Ewing, S and J Thomas. (2006) 'Wired High Rise: Community-Based Computer Network', In Marshall, S., Taylor, W and Y, Xinghuo. (eds) *Using Community Informatics to Transform Regions*, Hershey, Penn: Idea Group. Also

published by: Swinbourne University of Technology, Institute of Social Research, Accessed 12.03.06, Available at: http://www.sisr.net

Michael, M. (2000) *Reconnecting Culture, Technology and Nature: From Society to Heterogeneity*, London: Routledge.

Michael, M. (2006) *Technoscience and Everyday Life, The Complex Simplicities of the Mundane,* London: Open University Press.

Mills, W. C. (1959) *The Sociological Imagination*, Oxford: Oxford University Press.

Miller, D. (1987) *Material Culture and Mass Consumption,* Oxford: Basic Blackwell.

Miller, D and D, Slater. (2000) *Internet: An Ethnographic Approach*, Oxford: Berg.

Mirzoeff, N. (1999) (ed) *Visual Culture Reader*, London and New York: Routledge.

Mol, A. (1999) 'Ontological Politics: A World and Some Questions', In J, Law and J, Hassard. (eds) *Actor Newtork Theory and After*, Oxford: Blackwell Publishers, pp. 74-89.

Mol, A. (2001) 'Situating Technoscience: An Inquiry into Spatialities', Environment and Planning, Part D, *Society and Space*, 19, pp. 609-621.

Mol, A. (2002) *The Body Multiple: Ontology in Medical Practice*, Durham, NC and London: Duke University Press.

Mol, A and J, Law. (1994), 'Regions, Networks and Fluids: Anemia and Social Topology', *Social Studies of Science*, 24, pp. 641-671.

Morris, S. (2004) 'Make New Friends and Kill Them: Online Multiplayer Computer Game Culture', In G, Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 133-144

Moyal, A. (1987) 'Invention and Innovation in Australia: The Historian's Lens', *Prometheus,* 5 (1), pp. 93-110.

Myers, N. (2008) 'Molecular Embodiments and the Body-Work of Modeling in Protein Crystallography', *Social Studies of Science*, 38 (2), pp. 163-199.

National Library of Australia. (2006) Accessed 24.09.06, Available at: http://nationaltreasures.nla.gov.au

Negroponte, N. (2002) 'Being Wireless', *Wired Magazine*, 10th October, Accessed 16.02.05, Available at: http://www.wired.com

Newell, R. (1995) 'Questionnaires', In N, Gilbert. (ed) *Researching Social Life*, London: Sage, pp. 94-115.

Nippert-Eng, C. E. (1996) *Home and Work: Negotiating Boundaries through Everyday Life*, London: University of Chicago Press.

Node DB. (2006) *Node Database*, Accessed 10.04.06, Available at: http://www.nodedb.com

Norris, P. (2001) *Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide,* Cambridge: Cambridge University Press.

NSO (National Statistics Online). (2003) *Census 2001: Households*, 7th May, Accessed 2.03.06, Available at: http://www.statistics.gov.uk

NSO. (2006) *Households with Internet Access: By Household Type: Social Trends 34,* 4th May, Accessed 22.03.05, Available at: http://www.statistics.gov.uk

NSO. (2006b) *Lifestyles and Social Participation: Highlights*, 4th May, Accessed 22.03.06, Available at: http://www.statistics.gov.uk

NSO. (2008) *Population Estimates: UK population grows to 60,975,000*, 21st August, Accessed 22.10.08, Available at: http://www.statistics.gov.uk

NYC Wireless. (2008) *New York City Volunteer Community Wireless Network*, Accessed 23.10.08, Available at: http://www.nycwireless.net

Oates, J. (2008) 'ISP Boss Pledges to Undermine Great Aussie Firewall: Stupid Plan is Stupid', *The Register Online*, 12th November, Accessed 12.12.08, Available at http://www.theregister.co.uk/2008/11/12/aussie_firewall_row/

O'Connor, E. (2005) 'Embodied Knowledge: The Experience of Meaning and the Struggle Towards Proficiency in Glassblowing', *Ethnography*, 6 (2), pp. 183-204.

Optus. (2006) *Get started with Optus. Broadband the Simple Way,* Accessed 21.03.06, Available at: http://www1.optusnet.com.au

Oudshoorn, N., Rommes, E, and M, Stienstra. (2004) 'Configuring the User as Everybody; Gender and Design Cultures in Information and Communication Technologies', *Science, Technology & Human Values,* 29 (1), pp. 30-63.

Overall, C. (1988) 'Feminism, Ontology and 'Other Minds', In L, Code, Mullett, S and C, Overall. (eds) *Feminist Perspectives: Philosophical Essays on Method and Moral,* Canada: University of Toronto Press, pp. 89-105.

Ovum. (2006) *UK Broadband Status Report, June 2005*, Accessed: 14.04.06, Available at: http://www.egovmonitor.com

Oxford. (2001) *Compact Oxford Dictionary, Thesaurus and Wordpower Guide*, New York: Oxford University Press.

Oxford Internet Institute. (2005) 'The Internet in Britain'. *The Oxford Internet Survey*, University of Oxford, Accessed 22.04.06, Available at: http://www.oii.ox.ac.uk

Paulos, E and E, Goodman. (2004) *The Familiar Stranger: Anxiety, Comfort, and Play in Public Places,* Conference on Human Factors in Computing Systems, Vienna, Austria, Accessed 15,11,08, Available at: http://portal.acm.org/citation.cfm?id=985721

Pease, B and K, Pringle. (2001) *A Man's World; Changing Men's Practices in a Globalised World*, New York: Zed Books.

Personal Telco. (2006) *Portland, Oregon Volunteer Community Wireless Group*, Accessed 2.02.06, Available at: http://wiki.personaltelco.net

Pink, S. (2001) *Doing Visual Ethnography: Images, Media and Representation in Research*, London: Sage.

Pink, S. (2003) 'Interdisciplinary Agendas in Visual Research: Re-Situating Visual Anthropology', *Visual Studies* 18 (2), pp. 179-192.

Pink, S. (2004) 'Review of Researching The Visual: Images, Objects, Contexts and Interactions in Social and Cultural Inquiry', *Sociological Research Online.* Accessed 05.11.06, Available at: http://www.socresonline.org.uk

Pollner, M and R, Emerson. (2002) 'Ethnomethodology and Ethnography', In Atkinson, P., Coffey, A.J., Delamont, S., Lofland, J., and L.H Lofland. (eds) *Handbook of Ethnography*, London: Sage, pp. 118-135.

Popper, K. R. (1972) *Objective Knowledge: An Evolutionary Approach*, Oxford: Oxford University Press.

Poster, M. (2002) 'Visual Studies as Media Studies', *Journal of Visual Culture,* 1 (1), pp. 67-70.

Procter, M. (1995) 'Measuring Attitudes', In N, Gilbert. (ed) *Researching Social Life*, London, Sage, pp.116-134.

Prosser, J. (ed) (2003) *Image-Based Research; A Sourcebook for Qualitative Researchers*, London: Routledgefalmer.

Pryke, M., Rose, R and S, Whatmore. (eds) (2003) *Using Social Theory: Thinking Through Research*, London: Sage Publications.

Purdue, D., Dürrschmidt, J., Jowers, P and R, O'Doherty. (1997) 'DIY Culture and Extended Milieux: LETS, Veggie Boxes and Festivals', *The Sociological Review*, 45 (4), pp: 645-667.

Reckwitz, A. (2002) 'Toward a Theory of Social Practices', *European Journal of Social Theory*, 5 (2), pp. 243-263.

Rose, G. (1993) *Feminism and Geography: The Limits of Geographic Knowledge*, Oxford: Polity Press.

Reid, D. (2005) 'Macedonia leads world with WiFi', *BBC News*, Accessed 10.03.06, Available at http://news.bbc.co.uk

Reinelt, J and J. R. Roach. (1992) *Critical Theory and Performance*, Michigan: University of Michigan Press.

Rennie, E and S, Young. (2004) 'Park Life: The Commons and Communications Policy', In G. Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 242-257.

Richardson, T. (2004) 'BT's DSL market share carries on falling', *The Register*, 29th June, Accessed 13.02.06, Available at: http://www.theresgister.co.uk

Roush, C. (1999). *Inside Home Depot: Home One Company Revolutionised an Industry Through the Relentless Pursuit of Growth*, New York: McGrath Hill.

Rogoff, I. (1999) 'Studying Visual Culture', In Mirzoeff, N. (ed) *Visual Culture Reader*, London and New York: Routledge, pp. 4-13.

Rose, G. (2001) *Visual Methodologies*, London: Sage Publishing.

Rose, G. (2003) 'A Body of Questions', In Pryke, M., Rose, R and S, Whatmore. (eds) *Using Social Theory: Thinking Through Research*, London: Sage Publications, pp. 47-64.

Roush, C. (1999)

Rutter, J and G. W. H. Smith (2002) 'Ethnographic Presence in Nebulous Settings: A Case Study', *ESRC Virtual Methods Seminar*, 19th April, UK: Brunel University.

Sandvig, C. (2003) 'Shaping Infrastructure and Innovation on the Internet: The End-to-End Network that isn't', In D. Guston and D, Sarewitz. (eds) *Shaping Science and Technology Policy: The Next Generation of Research*, Madison: University of Wisconsin Press, Accessed 10.02.06, Available at: http:// www.spcomm.uiuc.edu

Sandvig, C. (2004) *An Initial Assessment of Cooperative Action in Wi-Fi Networking*, Telecommunications Policy, 28 (7/8), pp. 579-602.

Sandvig, D., Young, D and S, Meinrath. (2005) *Hidden Interfaces to "Ownerless" Networks*, The Economist, "Wireless Broadband" 8-14th January, (online), Accessed 10.10.05, Available at: http://www.spcomm.uiuc.edu/csandvig/research/

Saussure, F. (1915) *Course in General Linguistics*, New York: The Philosophical Library Inc.

Sawhney, H. (2005) 'Wi-Fi Networks and the Reorganisation of Wireline-Wireless Relationship', In R, Ling and Pedersen, P. (eds) *The Mobile Connection: The Cell Phone's Impact on Society*, London: Springer-Verlag, pp. 45-62

Scalmer, S. (2002) *Dissent Events: Protest, the Media and the Political Gimmick in Australia*, Sydney: University of New South Wales Press.

Schatzki, T. (1996) *Social Practices: A Wittgensteinian Approach to Human Activity and the Social*. Cambridge: University Press.

Schofield, J. (2005) 'One Size Fits All Networks: Competition is Hotting Up as Television, Phone Calls and the Internet are Delivered form a Single Source', *The Guardian Online*, 30th June, Accessed 12.11.07, Available at: http://www.guiardian.co.uk

Schonfeld, E., Malik, O and M.V, Copeland. (2006) 'Social Media: Who Needs TV Networks and Film Studios? Netizens are Creating Their Own Blogs, Photos and Videos and That's Translating into Hundreds of Promising New Businesses', *CNN Money*, 28th February, Accessed 10.03.06, Available at: http://money.cnn.com

Science and Technology Innovation. (2006) *The Adelaide Innovation Constellation*, Government of South Australia, Accessed 12.04.06, Available at: http://www.innovation.sa.gov.au

Searle, D. (ed) (1997) *Gathering Force: DIY Culture – Radical Action For Those Tired of Waiting*, London: The Big Issue Writers.

Servon, L. (2002), *Bridging the Digital Divide: Technology, Community, and Public Policy*, Malden, MA: Blackwell.

Shove, E and M, Pantzer. (2005) 'Consumers, Producers and Practices: Understanding the Invention and Reinvention of Nordic Walking', *Journal of Consumer Culture*, 5 (1), pp 43-64.

Shove, E., Watson, M., Hand, M,. and J, Ingram. (2007) *The Design of Everyday Life*, Oxford and New York: Berg.

Silverman, D. (2001) *Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interaction*, London: Sage.

Silverman, D. (ed) (2004) *Qualitative Methods: Theory, Method and Practice*, London: Sage.

Silverstone, R and E, Hirsh. (eds) (1992) *Consuming Technologies: Media and Information in Domestic Spaces*, London and New York: Routledge.

Singleton, V. (1998) 'Stabilizing Instabilities: The Role of the Laboratory in the United Kingdom Cervical Screening Programme', In Berg, M and A, Mol. (eds), *Differences in Medicine: Unravelling Practices, Techniques and Bodies*, Durhan, NC: Duke University Press.

Singleton, V and M, Michael. (1993) 'Actor-networks and Ambivalence: General Practitioners in the UK Cervical Screening Programme', *Social Studies of Science*, 23, pp. 227-264.

Skeggs, B. (2002) 'Feminist Ethnography', In Atkinson, P., Coffey, A.J., Delamont, S., Lofland, J., and L.H Lofland. (eds) *Handbook of Ethnography*, London: Sage, pp. 426-442.

Skrbis, Z. (2006) 'Australians In Guantanamo Bay: Gradation of Citizenship and the Politics of Belonging', In Yuval-Davis, N., Kannabiran, K and U, Vieten. (eds) *The Situated Politics of Belonging*, London: Sage Publications, pp. 176-190.

Smith, T. (2008) 'Great Aussie Firewall' Angers Backers of Free Speech Online', *The News Tribune*, 28th December, Accessed: 30.12.08, Available at: http://www.thenewstribune.com/business/story/578859.html

Star, S, L. (1991) 'Power, Technology and the Phenomenology of Conventions: On Being Allergic to Onions', In J, Law. (ed) *Sociology of Monsters: Essays on Power, Technology and Domination*, London: Routledge.

Star, S, L. (1995) *Cultures of Computing,* UK: Wiley-Blackwell.

Star, S, L. (1999) 'The Ethnography of Infrastructure', In P, Lyman and N, Wakeford. (eds) *Analysing Virtual Societies: New Directions in Methodology, American Behavioural Scientist*, 43 (3), pp. 377-391.

Stanley, L and S, Wise. (1993) *Breaking Out Again: Feminist Ontology and Epistemology*, London and New York: Routledge

Star, S. L and J. R. Griesemer. (1999) 'Institutional Ecology, 'Translations,' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-1939', In M, Biagioli. (ed) *The Science Studies Reader*, New York: Routledge, pp. 505-524.

Sturken, M and L, Cartwright. (2001) *Practices of Looking; An Introduction to Visual Culture,* Oxford: Oxford University Press.

Suchman, L. (2002) 'Located Accountabilities in Technology Production', *Scandinavian Journal of Information Systems,* 14, pp. 91-105.

Sydney Morning Herald. (2006) *Internet takes on TV in Britain: Survey,* 9th March, Accessed 10.04.06, Available at: http://www.smh.com.au

Sydney Morning Herald. (2006b) *Australia Web Access Running at a Crawl,* 9th March, Accessed 10.04.06, Available at: http://www.smh.com.au

Sydney Wireless. *Sydney Volunteer Community Wireless*, Accessed: 3.01.06, Available at: http://sydneywireless.com

Tacchi, J and B, Grubb. (2007) 'The Case of the E-Tuktuk', In G, Goggin and M, Gregg. (eds) (2007) *Wireless Cultures and Technologies,* Media International Australia: The University of Queensland, pp. 71-82.

The Cloud. (2006) 'City of London goes Wi-Fi', Press Release, 20th February, Accessed 20.04.06, Available at: http://www.thecloud.net

The Mesh dot org. (2006) *Volunteer Community Wireless Group in Darwin*, Accessed 10.02.06, Available at: http://the-mesh.org

The World Summit of Free Information Infrastructures Conference (WSFII). (2005) 1st - 2nd October, London, UK: Limehouse Town Hall.

Taylor, T, L. (1999) 'Life in Virtual Worlds', In P. Lyman and N. Wakeford. (eds) *Analysing Virtual Societies: New Directions in Methodology,* American Behavioural Scientist 43 (3), pp. 436-449.

Telstra. (2007) *BigPond Wireless Broadband*, Accessed 04.10.07, Available at: http://beeneverywhere.com.au

Telstra. (2007b) *Telstra Wireless Hotspot Access - Big Pond*, Accessed 1.05.07, Available at: http://www.bigpond.com/

Telstra. (2008) *Wireless Broadband, Plans and Offers*, Accessed 07.08.08, Available at: http://my.bigpond.com/internetplans/broadband/wireless/plansandoffers/default.jsp

Thompson, E. (1994) *Fair Enough: Egalitarianism in Australia*, Sydney: University of New South Wales.

Thompson, M. (1979) *Rubbish Theory: The Creation and Destruction of Value*, Oxford: Oxford University Press.

Thomson, M. (1999) *Blokes & Barbies: The Legendary Australian Barbeque: Meat, Metal and Fire,* Sydney: Harper Collins Publishers.

Thomson, M. (2002) *The Complete Blokes & Sheds: Stories From the Shed. Behind the Corrugated-Iron Curtains of Australia's Sheds,* Sydney: Harper Collins Publishers.

Thomson, M. (2002b) *Rare Trades: Making Things by Hand in the Digital Age,* Sydney: Harper Collins Publishers.

Thomson, M. (2006) 'I tinker therefore I am', *Monograph Series 9*, Deer Isle, ME: Haystack Mountain School of Crafts.

Thomson, M. (2007) *Makers, Breakers and Fixers: Inside Australia's Most Resourceful Sheds,* Sydney: Harper Collins Publishers.

Thomson, M. (2007b) *Henry Hoke's Guide to the Misguided*, Sydney: ABC Books.

Thomson, M. (2008) *Institute of Backyard Studies*, Accessed 23.07.08, Available at: http://www.ibys.com.au

Tofts, D. (2004) 'Cybers of the Virtual: Australian Net Art and the Metaphysics of Telepresence', In G. Goggin. (ed) *Virtual Nation: The Internet in Australia*, Sydney: University of New South Wales Press, pp. 146-158.

Tourism Australia. (2008) Accessed 12.12.08, Available at: http://www.tourism.australia.com

Traweek, S. (1988) *Beamtimes and Lifetimes: The World of High Energy Physics,* Cambridge MA: Harvard University Press.

Treichler, P, A., Cartwright, L and C, Penley. (eds) (1998) *The Visible Woman; Imaging Technologies, Gender and Science,* New York and London: New York University Press.

Turkle, S. (1995) *Life on the Screen: Identity in the Age of the Internet*, London: Weidenfeld & Nicolson.

Turnball, D. (2000) *Masons. Tricksters and Cartographers: Comparative Studies in the Sociology of Scientific and Indigenous Knowledge,* Amsterdam: Hardwood Academic Publishers.

Turnball, S. (2008) 'Mapping the Vast Suburban Tundra; Australian Comedy from Dame Edna to Kath and Kim', *International Journal of Cultural Studies*, 11 (1), pp. 15-32.

Turnball, S. (2008b) 'Suburbia, Understanding Australia - Program 5', Interviewed by Sue Slamen, *Radio Australia, Australian Broadcasting Corporation*, Accessed 06.10.08, Available at: http://www.radioaustralia.net.au

Turner, A. (2007) 'Telstra FttN Plan Back on the Table, Labour Needs to Match It', *IT Wire,* 3rd April, Accessed 14.10.08, Available at: http://www.itwire.com

Turner, A. (2007b) 'Where's My Free WiFi?' *SMH Gadgets on the Go*, 8th October, Accessed 8.10.07, Available at: http://www.smh.com.au

Tusa, J. (-) *Transcript of the John Tusa Interview with David Hockney*, The John Tusa Interviews, BBC Radio 3, Accessed 07.08.08, Available at http://www.bbc.co.uk/radio3

Vergunst, J, L. (2008) 'Taking a Trip and Taking Care in Everyday Life', In T, Ingold and L, Vergunst. (eds) *Ways of Walking: Ethnography and Practice on Foot,* Hampshire, England: Ashgate, pp. 105-123.

Wajcman, J. (1991) *Feminism Confronts Technology,* Pennsylvania: Pennsylvania State University Press.

Wajcman, J. (2004) *Technofeminism*, Cambridge MA: Polity Press.

Wakeford, N. (1999) 'Gender and the Landscape of Computing in an Internet Café', In M, Crang and J, May. (eds) *Virtual Geographies: Bodies, Space and Relations*, London: Routledge, pp.178-213.

Wakeford, N. (2000) 'New Media, New Methodologies: Studying the Web', In D, Gauntlett. (ed) *Web.Studies: Rewiring Media Studies for the Digital Age,* London: Arnold, pp. 31-41.

Wakeford, N. (2003) 'The Embedding of Local Culture in Global Communication: Independent Internet Cafes in London', In *New Media & Society*, 5 (3) pp. 379-399.

Wakeford, N. (2003b) 'Research Note: Working with New Media's Cultural Intermediaries; The development of collaborative projects at INCITE', *Information, Communication and Society*, 6 (2), pp. 229-245.

Ward, M. (2002) 'Chalk Points to Wireless Internet', *BBC News,* Accessed 2.03.05, Available at: http://news.bbc.co.uk/1/hi/technology/2144279.stm

Ward, M. (2002b) 'Hacking with a Pringles Tube', *BBC News*, 8th March, Accessed 9.09.05, Available at: http://news.bbc.co.uk/1/hi/sci/tech/1860241.stm

Ward, M. (2006c) 'WiFi Set to Re-Wire Social Rules', 8th March, *BBC News,* Accessed 12.10.07, Available at: http://www.news.bbc.co.uk

Warde, A. (2005) 'Consumption and Theories of Practice', *Journal of Consumer Practice*, 5 (2), pp. 131-153.

Wark, M. (2004) *A Hacker Manifesto*, Cambridge and London: Harvard University Press.

Waterton, C (2006) 'Amateurs as Experts: Re-thinking Expertise with Non-Expert Knowledges', *ESRC Research Report*, Accessed 10.07.08, Available at: http://www.esrcsocietytoday.ac.uk

Waterton C. and Ellis R. (2004) 'Environmental Citizenship in the Making: The Participation of Volunteer Naturalists in UK Biological Recording', *Science & Public Policy,* 31 (2), pp. 95-105

Watson (2008) 'Making do with Language', In P, Goldsworthy. *True Blue? On Being Australian*, Sydney: Allen & Unwin, p.198.

Watson, M and E, Shove. (2008) 'Product, Competence, Project and Practice: DIY and the Dynamics of Craft', *Journal of Consumer Culture*, 8 (1), pp. 69-89.

Weber, K. (1992) 'Imagining Utopia: The Selling of Suburbia', In *The Lie of the Land,* National Centre for Australian Studies, Melbourne.: Monash University. *Welcome to Uluru-Kata Tjunta National Park* n.d. (brochure) in *West Australian* 2005, 26-25 July.

Webster, R. (2000) *Expanding Suburbia: Reviewing Suburban Narratives,* Oxford and New York: Berghahn Books.

Webster, F. (2002) *Theories of the Information Society*, Second Edition, London: Routledge.

Webster, F. (ed) (2002b) *Culture and Politics in the Information Age: A New Politics?* London: Routledge.

Weinberger, D. (2007) *Everything Is Miscellaneous: The Power of the New Digital Disorder*, New York: Times Books, Henry Holt & Company.

Wellman, B and C, Haythornthwaite. (eds) (2002) *The Internet in Everyday Life*, Oxford, Blackwell.

Whatmore, S. (2003) 'Introduction: Investigating the Field', In Pryke, M., Rose, R and S, Whatmore. (eds) *Using Social Theory: Thinking Through Research*, London: Sage, pp. 67-70.

Whirlpool Broadband News. Accessed 10.07.08, Available at: http://www.whirlpool.net.au

White, R. (1981) *Inventing Australia: Images and Identity, 1688-1980,* Sydney: Allen & Unwin.

Williamson, J. (1978) *Decoding Advertisements: Ideology and Meaning in Advertising.* London: Boyars.

Winton, T. (2005) *Land's Edge,* Australia: Macmillian Publishers.

Wireless Anarchy. *Directory of Wireless Community and Information Links*, Accessed 10.07.08, Available at: http://www.wirelessanarchy.com

Woolgar, S. (1991) 'The Turn to Technology in Social Studies of Science', *Science, Technology & Human Values,* 16 (1), pp. 20-50.

Woolgar, S. (1993) *Science, The Very Idea.* London: Routledge.

Woolgar, S. (1996) 'Technologies as Cultural Artefacts', In W. H, Dutton and M, Peltu. (eds) *Information and Communication Technologies: Visions and Realities*, Oxford: Oxford University Press, pp. 87-102.

Woolgar, S. (ed) (2002) *VirtualSociety? Technology, Cyperbole, Reality*, Oxford: Oxford University Press.

Wyatt, S. (2008) 'Challenging the Digital Imperative', *Inaugural Lecture Presented upon to acceptance of the Royal Netherlands Academy of Arts and Sciences (KNAW) Extraordinary Chair in Digital Cultures in Development,* 28th March, The Netherlands: Maastricht University, Accessed 10.11.08, Available at: http://www.unimaas.nl

Wyatt, S., Thomas, G and T, Terranova. (2002) 'They Came, They Surfed, They Went Back to the Beach: Conceptualising Use and Non-use of the Internet', In S, Woolgar. (Ed) *Virtual Society? Technology, Cyperbole, Reality*, Oxford: Oxford University Press, pp.23-40.

Yaneva, A. (2005) 'Scaling Up and Down: Extraction Trials in Architectural Design, *Social Studies of Science,* 35 (6), pp 867-894.

Yaneva, A. (2005b) 'A Building is a Multiverse', In B, Latour and P, Weibel. (eds) *Making Things Public*, ZKM Karlsrhue, Cambridge: MIT Press, pp. 530-535.

Yeo, V. (2008) 'WiMAX Takes Blow in Australia', *Business Week*, 2nd April, Accessed 10.09.08, Available at: http://www.businessweek.com

Yuval-Davis, N., Kannabiran, K and U, Vieten. (eds) (2006) *The Situated Politics of Belonging,* London: Sage Publications.