Tuning In: Challenging Design for Communities through a Field Study of Radio Amateurs

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1. Introduction

As illustrated by the emerging field of Communities and Technologies, the topic of *community*, whether further qualified by 'virtual' (Rheingold 1993), 'on line' or 'networked' (Schuler 1996), has become a major focus for field study, design, technical infrastructural provision, as well as social, psychological and economic theorising. Let us review some early examples of this 'turn to community'. Mynatt et al. (1999) discuss the 'network communities of SeniorNet', an organisation that supports people over the age of 50 in the use of computer networking technologies. The SeniorNet study highlights the complex 'collage' of participation and interaction styles that community members sustain, many of which go beyond conventional understandings of older people, their practices and relations to technology. While the members of SeniorNet are geographically dispersed, Carroll and Rosson (1996) describe the 'Blacksburg Electronic Village', a local community computing initiative centred around Blacksburg, Virginia, USA. As long ago as 1994, Schuler (1994) claimed the existence of over 100 such projects in the US with very diverse aims and experiences but all concerned to be responsive to a community's needs while exploiting the Internet and the technical developments it has made possible. For their part, Koch and Wörndl (2001) offer some generic

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infrastructural tools for community computing, including support for 'identity management'.

Several researchers have reflected on the broader significance of computer supported or mediated communities. While Rheingold (1993) is a 'locus classicus' for much of the literature, researchers have seen the broader potential for networking technologies at least since Hiltz and Turoff's (1978) *The Networked Nation,* while others have studied Muds and MOOs as computer mediated communities of potential significance beyond their original gaming context (Pargman 2000, 2005). The authors in Smith and Kollock (1999) interpret 'communities in cyberspace' using contributions to contemporary social theory, focusing on questions of ethnic and gender identity, as well as theorisations of social power, economy and collective organisation.

While the interest in computing in relation to communities is palpable, and specific contributions are notable, the sheer variety of perspectives in the literature causes one to question whether 'community' is a unified research topic. When (rarely) such a fundamental notion is addressed conceptually, authors tend to be sceptical about its conceptual unity. For example, Erickson (1997) attempts a list of criteria for what community '*implies'* (perhaps already a slippage from *defining* community) and ultimately, in the face of his own studies, urges a shift of discourse to discuss 'participatory genres'. Pargman (2000, p.22) grapples with the concept in the following way: "community is characterized by shared rules, goals, concerns, routines, procedures, practices, rituals, symbols, artifacts, history and institutions as well as mutual commitment and responsibility to the community and to community members, not necessarily based on personal relationships". The trouble with such 'definitions' is their inclusiveness. It is hard to see what social phenomenon would *not* count as an instance of a community in action from this perspective. A second trouble is the definition's promiscuity. A listing is made of nearly every notion (rules, symbols, artifact and the rest) one can think of from the world of social analysis.

Rather than attempt a speculative delineation of the field ourselves, we would like to make a number of observations about research which takes 'community' as its topic in Human Computer Interaction (HCI) and related fields. We would suggest that to be concerned with community is an attempt to *reshape the research agenda* by opening up the interests to non-professional settings. The very emergence of the Communities and Technologies conference series is an artifact of such agenda transformation. We regard this as an attempt to take research beyond the 'world of work', narrowly defined. Although the tradition of studies of work, and of its techni-

cal support, might be drawn upon, one other concern is to study settings which are not defined by waged or salaried employment. In particular, there is interest in the fate of IT applications 'in the wild' in the hands of the characters Lave (1988) calls 'jpfs' (just plain folk). Through doing this, there is the possibility that HCI design methods and sensitivities, which have been honed in 'professional' application contexts (and which correspondingly often carry the marks of professional practice), might be revised or augmented.

We attempt to suggest such community-inspired revisions of method and understandings of work in this paper. We are sympathetic to attempts to secure a broad and vibrant research agenda for HCI and IT design-related fields and to reorient our concerns for 'work', 'technology' and 'design'. Our claim, which we hope to substantiate in this paper, is that field study can be particularly instructive in shaping and enriching research agendas and, as we shall see, in suggesting novel orientations for design in this context.

We have taken amateur radio enthusiasts (often known as Hams) as our community of study. There is prima facie interest and relevance of Hams for informing IT design for communities for a number of reasons. First, *communication and social interaction* are clearly central to such people (but, in advance of field study, we do not know how such interaction is organised). Second, the *technical mediation of communicatio*n is obviously crucial for them (but, again, in advance of study, we do not know how or in what respects). Third, radio amateurs are a *world wide community* (so studying them should inform us about how such a dispersal of members can be sustained). Fourth, radio amateurs are a *well established and enduring community*. The existence of the forms of communication associated with the Internet has not caused depletion in their numbers and they have survived many legal changes regarding the use of the airwaves. Their durability is something many virtual communities would aspire to. We hope our field study can illuminate how that robustness is achieved. Finally, and at the close of this paper, we show how studying radio amateurs has suggested a perspective on design ('designing for challenge'), which we hope is of interest in general.

2. Field Study

The fieldwork reported in this paper has been conducted from 1996 to 2004 in the ethnographically inspired tradition as developed in the field of Computer-Supported Collaborative Work (CSCW). During this time, ex-

tended periods of contact (e.g. up to 2 months at a time) have been spent in the company of radio amateurs. Observation has included sitting in on local radio club meetings, open-ended interviews with 12 radio amateurs, listening in, as well as being around when live radio contact is made (over 150 hours of contact time has been spent in this way). The research has involved study in Romania and Sweden, alongside reading background technical literature and amassing a corpus of related documents (e.g. local, national and international regulations and specifications of best practice, copies of magazines, radio connection confirmation cards, radio station logs). Recordings of radio-talk, and transcriptions, have been made. In addition, the first author attended a course for new radio amateurs seeking an elementary license. Throughout, permission and consent have been obtained from all participants. The study did not include 'Citizen Band' (CB) radio, which has more relaxed transmission rules and requires no official license, as more dedicated amateur operators were thought to exist within 'mainstream' Ham. All the operators followed happened to be male, which is (unfortunately) representative for the amateur radio population; female trainees were encountered at radio clubs though. A more exhaustive description of the field work can be found in (Bogdan, 2003).

2.1 Introducing Amateur Radio

Radio amateurs (Hams) share a passion for communication and for the means to achieve it over the radio wave. They communicate on globally reserved radio frequency ranges. Specific national bodies maintain codes of rules and regulations in accordance to which radio amateurs can be awarded a succession of operating licenses of several classes, gaining the right to emit on an increasing number of frequency ranges. Radio reception is free for everybody though, on any frequency, according to international regulations.

The radio amateur movement started at the beginning of the 20th century with regional 'radio networks', which turned into well-known 'calling frequencies' when communication became international. Radio transmitter-receiver (transceiver) equipment used to be shared in radio clubs. More recently, technology advancements have made it possible to produce transceivers owned by a single person, and to build transceivers at home.

Every radio amateur is officially registered with a unique *call sign*. The call sign is usually made of a group of letters indicating the country, a digit indicating the region, and another group of letters. For example, YO3GHI stands for an operator in the Bucharest region (3) of Romania (YO). Throughout this account, the first part of every call sign (denoting country

and region) has been preserved, while the second part has been changed for confidentiality reasons. Radio amateur names used in this account are fictional as well.

The call sign system is one of many amateur radio code systems. Such codes are useful in Morse telegraphy, still widely used in Ham communication, where it is essential for messages to be short. In case of poor transmission quality, words that start with a letter can be used to transmit the respective letter. A standard phonetic alphabet (alpha, bravo, charlie…) is recommended in such cases. Throughout the following transcripts, parts of Ham codes that are *not* pronounced in the phonetic alphabet are shown in capitals.

Talk on the radio is organised around *connections*, listening out for the opportunity, making them and maintaining them. To be sure, a connection is a technical achievement but it is also a social interactional phenomenon with a characteristic shape and with recognisable matters dealt with by participants in specific ways as they demonstrate their membership and competence in regard to the technical conditions of the connection, as well as in regard to the rules and regulations that govern it. Connecting with another operator is often referred to as '*working with*' that operator.

Radio connections can be achieved in a number of frequency ranges. The most typically used today are VHF (Very High Frequency) and SW (Short Wave). VHF requires cheap transceivers and low transmission powers. VHF is principally confined to local propagation, though transmissions can have a longer reach through the use of 'repeaters' which receive signals on one frequency and retransmit them on another. Short wave is based on the wave reflection on the ionosphere, and works over larger areas, including world-wide connections. Many beginners start by just listening (i.e. no transmission, working with just a receiver) to some local frequencies, with cheap or easy-to-build equipment, and slowly progress towards higher-power, larger-distance transmission modes, as they acquire the needed licenses and equipment.

2.2 Experimentation through Communication

From the early stages of our study, it became evident that amateur radio communication is often *unreliable* as a consequence of the various equipment configurations and manipulations tried out by the amateurs. The only definitive way to be certain of its reliability is through making or attempting to make connections. As one of the informants puts it

> I never know whether my transceiver works or not.

... never, that is, independently of its use in making connections of varying kinds and under varying conditions. Not surprisingly, the Ham frequencies are continuously used for testing equipment. A connection is always an opportunity to check the personal or radio club transceiver. Sometimes, checking is the explicit goal of the connection:

> I've just heard you and I thought I'd say hello to see if my tool works on (this frequency), and I reckon it works since you answered.

The lack of radio communication reliability may be surprising at first sight. Indeed, having a predictable communication medium can be perceived as an elementary provision for any community, especially a long-thriving one like Ham. For example, in their work on network communities, Mynatt et al. (1998) recommend that system should be "optimized for predictability" and offer "multiple modalities". In most of what follows, we will describe how amateur radio operators *prefer* the communication to be unreliable, in that they *like* to experiment with their equipment, exploring the connection possibilities that exist with a certain configuration. In the meantime, a lot of communication occurs within the community through other, more reliable and appropriate channels, such as the radio club meeting (for information and debates), magazines (for e.g. schematics). In a remark expressing a *rare* event, an informant says:

> I even dictated schematics on the radio wave.

Radio is thus not just a communication medium for Ham, it is also an *experimentation* medium. This experimental character of Ham work will be often re-iterated in the remainder of our account. In the following sections, we will examine Ham learning, equipment construction, ways to advance radio technologies, performance as understood by the community, and smaller, but equally important personal achievements. As we shall see, focusing on these aspects will allow us to offer an understanding of community endurance and suggest ways in which our perspective can inform ITC support for communities.

2.3 Learning by Listening

Many of the study informants indicated listening as one of the first steps in their becoming a Ham. Various circumstances (such as having built a simple radio receiver from a handful of parts) brought them the possibility of listening to low frequencies (thus reliable and easy to tune in to from a technical and skill standpoint) with high traffic, such as the frequencies used by air traffic control or airport control towers. Trying to make sense

of the content and the transmission routines is not an easy task, and the abilities acquired can be of great value in later conditions of weak or distorted reception. One of our informants, an experienced operator, often tunes in to such frequencies, as a high-traffic band is "never boring".

There are, indeed, lots of traffic skills to be learned. To be sure, many of the codes and rules are first learned in courses or by reading material. But listening to these rules *as practiced* in radio traffic is indispensable. In the following example, an experienced operator Ed (YO3EF) intervenes in an extended multi-party exchange, as he needs to transmit something of importance.

> YO2??:… microphone to you moncher, YO nine Fox Golf Hotel YO2 (inaudible)
>
> YO3EF/Ed: echo foxtrot
>
> YO9FGH: [after closing down his discussion with YO2] OK, Err, long live mister Eddie, with the appropriate apologies, microphone to You, YO3 echo foxtrot group YO9FGH

The last part of the YO2 operator's turn at the beginning is inaudible (hence one cannot know his call sign just from the above context). This is because Ed has intervened at the end of his turn, producing a burst of interference while announcing only two letters from his call sign (EF). In response, YO9FGH completed his discussion with YO2 and then immediately 'passed the floor' to Ed, apologising for making Ed wait for him to finish ("long live mister Eddie […] apologies, microphone to You"). YO9FGH's turn ends formally with the two call signs, specifying "group" to emphasize that a (not so common) multi-party connection is going on.

In his intervention, Ed exploited a well-known short wave phenomenon: in the first seconds of transmission, the signal is very powerful and can cover other transmissions on the same frequency. He sent the part of his call sign that distinguishes him best (EF from YO3EF) but not more, in order not to excessively disrupt the traffic. The traffic continued, and his request to intervene was granted at the end of the next turn.

In strictness, producing interference is forbidden. However, Ed artfully minimises the disruption he causes by carefully designing how he identifies himself and when he does so. In this case, YO2 and YO9FGH are willing to give way and allow Ed to use the frequency, in part, no doubt because of the respect Ed commands. Listening repeatedly to such interactions instructs the listener in many features of relevance to the constitution and practice of the radio community. The listener can learn to recognise

important personalities, while understanding how to artfully deploy the radio waves.

In addition, listening in hones practically relevant perceptual skills. While improving the quality of radio communication is a broad goal of amateur radio activity, we will shortly see that many Hams are preoccupied with developing novel kinds of radio transmission, leading to experimental settings, often with poor quality reception. Listening skills are essential during such quests. We are, thus, a long way off from any notion that listening without contributing should be deemed 'lurking' like some perspectives might be tempted to (e.g. Kollock and Smith 1996). Besides acquiring 'civility' and knowing how to practice 'common resource sparing' (cf. Nonnecke and Preece 2000), in amateur radio, listening is not only how one learns, it is *what* one learns.

2.4 Continuously Perfecting the Equipment

While factory-made transceivers are produced, Ham equipment set-ups are often experimental. For example, we encountered an operator using two transceivers to work the waves achieving superior emission with one of them and superior reception with the other. His new transceiver has good reception but can't transmit to a local repeater. Accordingly, he retains his old transceiver for emission.

While transceivers can be bought, antennae always need to be built and carefully tuned, therefore they are a major point of interest for Hams. Walking on the street with a radio amateur will make one realise the importance of antennae for the Ham operators. A radio amateur will immediately distinguish the Ham aerials from the normal TV ones. He or she will also notice other antennae such as those used for GSM or by Internet providers, government services, embassies, and so forth. We heard the home of a Ham operator described to another Ham like this:

> Go along street X and you'll see a 7-element Yagi [antenna]; that's where he lives.

Improving one's transceiver or antenna by acquisitions and equipment combination is one way to continuously develop one's capability for radio communication. Another way is to do things *differently*, to experiment with various technical solutions. Designs that work well are always shared by word of mouth, at meetings, in magazines or on radio itself. Original designs or improvements bring pride and prestige to the authors.

> You should never be fond of a schema that you copied; you should always make a personal improvement when applying it. (YO)3DEF is now trying

> to make a frequency divisor based on [this brand new principle]. If it works for him, I'll make a similar circuit, but not an identical one!

Building and tuning more powerful and accurate equipment is thus a continuous Ham concern. Creativity and originality in equipment building and set-up becomes even more apparent as the complexity and power of the 'working mode' (VHF, short wave, etc) increases. In such conditions, it is no wonder that people in the surroundings of Ham operators report a sense of 'never-ending work' when characterizing what their relative, loved one or friend is involved in. A Swedish radio-amateur's wife sketched a cartoon of an antenna on the label of a binder in his radio room. Next to this she wrote:

> Terry's project. The never-ending story.

There is no obvious limit to the number of possibilities that could be tried out, no matter how rich or poor the operator is. Operators will always find new ways to build or assemble equipment for existing or for new purposes. The work is never to finish, Hams will always be testing new ideas. To discuss the ideas and to test them, operators cannot do so alone; they need to be part of the community, and they need to make radio connections.

2.5 Research for the Community and for the Public at Large

Continuous improvement of radio communication on the part of amateur radio operators comes from the desire to make efficient use of available emission power by achieving high-quality or long-distance connections. Sometimes, ground-breaking solutions are found, which are more remarkable than schematic design improvements. Examples of such new approaches are: new ways to modulate the signal (historically: first in amplitude, then in frequency, with a number of variations for each), new modalities of propagating the signal (e.g. by ionosphere reflection in short wave), and so forth.

In 1964, a USA operator held a connection with an Australian Ham by achieving, for the first time, radio wave (VHF) reflection on the moon, a technique which has since come to be known as EME (Earth-Moon-Earth). Such techniques need very special directional antennae and more emission power than normal (local) VHF.

Promoters of relative novelties like EME bring to the whole community a new 'dimension', a new space of possibilities, where new kinds of equipment can be built or assembled, new technical solutions can be tested, new connections made. In many respects, one can compare the con-

tinuous striving for improvement of radio connection with a research process. As we will see below, members themselves make the analogy. In these terms, ground-breaking achievements such as the inception of EME open new 'research programs'.

Sometimes such steps forward have been adopted by agencies beyond the Ham community. In fact, the well-known radio bands that are used today for broadcast radio are partially the result of Ham research. Occasionally, legal changes have then modified radio amateurs' existing practice, removing access to a particular frequency range. For radio amateurs, this can lead to resentment, even though it may also confirm their perception of the community's general value. One informant describes this process as follows:

> First they [the regulators] took LW [Long Wave] away from us, we moved into AM [Amplitude Modulation, Medium Wave], now we have no frequencies left there. We then found SW [Short Wave, High Frequency]. We have always had a research value for radio.

Another reason reported by members for their continuous concern with improving their equipment is *readiness* to communicate in even the harshest conditions. Informants have indicated a sense of freedom and social responsibility given by their transceiver, as they may be able to communicate even in disaster situations (wars, earthquakes, flooding) when public communication and power services may be down. Indeed, there exist Ham plans of action and band allocation in case of disaster, sometimes referred to as 'emergency networks'. In all these respects, Hams commonly regard themselves not as a socially irrelevant group of hobbyists but as acting for the public good and in readiness to serve.

2.6 Long Distance Connections

The Christmas edition of *DUBUS,* a German amateur radio magazine, closes with:

> Merry Xmas, HNY and good DX in 1998…

In the encoded Ham vocabulary, DX (delta X-ray) stands for 'long distance connection'. Typically, for a Ham, DX will mean inter-continental connections. The normal mode to achieve DX is short wave. Due to short wave technical difficulties and irregularities of its propagation (different frequencies work long-distance at different times of day, in different atmospheric and electro-magnetic conditions) a DX connection is a very im-

pressive achievement. The following announcement appeared on the cover of a Swedish Ham magazine:

> Two Swedish DXers with 300 countries on CW!

Having 300 countries worked, especially on telegraphy (CW) is a very impressive achievement, and implies working with rare countries (ones with few Ham operators), as well as working over an extended period. While talking about rare destinations, a radio club leader informed us:

> Think of an operator who goes to an isolated island with his equipment. He is there for a whole world! […] When I realize that there is good propagation with a rare zone, I try to announce it to as many operators as I can. Imagine when you find out that there is Tanzania on frequency X…

Seeking out DX, then, can be a cooperative affair as one operator helps others to locate areas of good propagation. He continues:

> We're all fascinated by propagation mysteries. We use beacons [radio automatons that keep sending the same message periodically on a frequency, not necessarily a Ham one] to monitor propagation. When we hear a beacon that we know is far away, we know there is a good propagation to that place.

Let us follow Arthur for a moment as he searches out DX opportunities, sitting in Stockholm in front of the club's short wave transceiver, browsing frequencies with the tuning knob. Arthur keeps complaining about the propagation, but he is hopeful.

> Unbelievable how bad it works this morning. 24 and 28 [MHz frequency bands] are completely dead […]. It [the propagation] should open soon. Around eleven. […] You'll see in half an hour, there won't be any space left around here.

Even if propagation is not 'open' yet by Arthur's standards, he can hear several calls. One call (represented by QRZ, or CQ) is from the Balearic Islands:

> EA6FG: EA6FG … calling Delta X-ray. This is echo alpha six foxtrot golf … echo alpha six foxtrot germany, Balearic Islands, QRZ DX
>
> EA6FG: CQ DX CQ calling delta X-ray CQ DX calling delta X-ray echo alpha six foxtrot golf, echo alpha six foxtrot golf Balearic Islands, QRZ DX over
>
> Arthur:[to first author] I am not DX for him […]. Think of it, maybe he's been working on the frequency for some hours 'cause he's determined to work Korea today. I shouldn't bother him

So Arthur doesn't answer the call. When hearing call signs, Arthur scribbles them on a piece of paper. He checks the call signs on a specialized website and the official information of the operator comes up (it turns out that the Balearic operator is working from the local airport). As the web site access is quite slow, Arthur supposes:

> maybe there is a contest and everybody is looking at these sites to see who they are hearing [From time to time, Hams enter contests which typically involve maximising the number of connections made under fixed transmission conditions.]

Arthur's antenna is directed towards North. A world map centred in Stockholm helps him determine where the emitted signal is likely to arrive. Arthur traces an imaginary line over Alaska, Canada, arriving in Mexico.

> You see, Americans will wake up soon, and my antenna beams towards them.

Browsing around, Arthur notices a station with a really weak signal. As an experienced Ham, he is able to realise that this signal does not promise DX.

> Ha, you suspect a really impressive DX and then it turns out that he's here, near you, he's just beaming far away, parallel with you, so you hear him badly.

Arthur's persistent searching for and reasoning about DX testifies to its importance for Ham radio operators – as does his sensitivity to what would count as DX for others who are working the waves at the same time. The activity of seeking out DX compactly expresses a number of prominent features of amateur radio practice. Long distance transmission and reception provide critical tests for the quality of the equipment used by the operator and any ingenious modifications that may have been made to it. DX exposes the operator to the "mysteries of propagation" and requires the skillful interpretation of what is being heard. Contingencies of propagation may be cooperatively managed as operators alert each other to DX opportunities. All the while, the Hams are deepening their sense of communally working the radio waves to connect with each other.

2.7 Other Notable Achievements

Not all the connections that are important for a Ham operator are DX connections.

> I came from Gherla to Omu [mountain peak, South of Transylvania] with four watts

Although this distance of about 400 kilometres is small compared to a DX connection, it is a lot when the emission power is only 4 watts. Equally, while getting from Romania to Germany is not a problem with short wave, doing it on VHF (2 meter) is an important achievement:

> From Vladeasa [mountain peak, West of Transylvania] I can get to Germany on two-meter!

When a connection is important for one of the parties, the operator requests a QSL card. In telegraphy, QSL means 'I confirm reception'. The QSL card contains the data of the connection as taken from the log. An informant explains:

> Of course it's nice to go to the radio club and show them my latest QSL with some remote country […]. But I might put a QSL on my wall even if it's not a DX. I might be happy because it is the first connection with a new antenna that I built.

An informant talks about one of his QSLs as follows:

> Right, it is [a connection with] somebody from [my country]. But look at the [connection] mode. It is EME! If it's EME, it can be the neighbour from the same block; it's still an excellent [connection]!

The exotic nature of the connection method (EME) makes this a notable connection. Earlier we mentioned how EME has opened up a new area for exploration by Hams. Part of the fascination of EME derives from the variety of different technical arrangements that can be experimented with to support it. Although all set-ups involve the use of a variety of antennae, exactly how they are made to work together and the power they consume are factors which vary greatly. To find out about different set-ups for EME, it is not uncommon for Hams to visit each other. Such visits often encourage bold experimentation. For example, during a visit to an EME installation which benefited from world class equipment, a Ham partook in an experiment in which voice (rather than Morse telegraphy usual in such low-quality long-distance connections) was transmitted via the moon.

It should be clear by now that there are many paths to valuable community experience and participation in amateur radio. Some of these are based around securing long distance communication. Others around the artful use of low power equipment. Yet others concern pioneering and remarkable experiments like bouncing radio transmitted voice off the moon. Some operators attempt high performance solutions, others are enthusiastic about their first connections using new equipment. Most are happy to

take advantage of set-ups made by peers (at home or in radio clubs) to get the feeling of working in a new band or how to use a new transmission mode. One does not need to aim for high technical performance or make costly investments to feel the challenge of continuously responding to radio's contingencies.

2.8 Organising a Connection

Connections (or QSOs as Hams commonly call them) are organised turn-by-turn, topic-by-topic in ways which reflect many of the features of amateur radio life that we have discussed. QSOs are commonly structured as follows:

- opening a connection
- the main body of the QSO which will typically involve
  - exchanging nicknames and locations
  - reporting on transmission quality (including talk about the weather)
  - describing 'working conditions'
- thanking and closing

We do not have space to analyse out each of these episodes in a connection in depth but let us make some brief observations.

Remember that operators each have an individual call sign. This immediately gives information about where they are registered. This is not necessarily though where they are transmitting from and, during the course of a connection, Hams will invariably make their location clear. Within a few turns, then, both parties to a connection will know each other's identities and relative locations. The unusualness of any location (e.g. if someone is mobile, on top of a mountain, or transmitting from a rare location) can then become an immediate topic for talk. A DX can be picked up swiftly, which is just as well as propagation conditions may not permit a lengthy connection. If one's interlocutor is an especially famous operator, a humble request for a QSL card may already be crossing one's mind.

As part of this or shortly following, Ham operators report reception quality to each other. There are standard formats for so doing. For example, in the case of communication through VHF repeaters, the indicator is the letter Q plus a measure of the 'readability', from 1 to 5, with 5 being the best quality.

As we have already noted, Hams often refer to the activity of making and maintaining connections as 'work'. Relatedly, the equipment an operator will use, and its characteristic features, are taken to comprise the

operator's 'working conditions'. Ham operators very typically exchange descriptions of their working conditions within a QSO. This, together with knowing their relative locations, helps them get a better understanding of the transmission/reception quality they have just reported to each other.

> Andy: Err I use a RTP with zero six, maximum zero seven Watts with own antenna. Errr, but the zone is very well chosen.

Here, Andy describes a low-power ex-police transceiver, adapted to work in Ham VHF bands. He goes on to explain that the hill where his student hostel is situated gives very good communication with the repeater. Shortly following this, Colin wonders whether the connection with Andy can continue without passing via the repeater. Andy's transceiver works pretty well on the local repeater with its standard antenna, but he also sees the opportunity to experiment with a new aerial that he has built.

> Colin: Would you like to try directly? Depends on your antenna, if it is directive
>
> Andy: Yes, yes, wait a second, I have a Yagi with five elements
>
> Colin: On forty-five five hundred
>
> Andy: OK, I'll make three calls there. But I don't know really if it still works, I'm not sure, I think the cable is broken. Let's try for fifteen seconds, if not, we get back on the repeater, OK?
>
> Colin: Yes, OK
>
> Andy [to first author]: I don't think it works now, 'cause some drunken blokes found it funny to go up on the roof and they tripped up on my cable.

Here, Colin suggests a well-known local call frequency (145500 MHz) for the test. Andy proposes a testing strategy, connects his aerial and waits. Then he disconnects it and goes back to the initial set-up. He can hear Colin coming back on the repeater frequency and calling:

> Colin: YO three alpha bravo charile mobile YO five charlie delta echo mobile
>
> Andy: YO five charlie delta echo mobile YO three ABC mobile. Errr, I didn't, didn't hear anything, I guess that nor did You.
>
> Colin: No I didn't, never mind, we'll do it some other time. It was a pleasure, and I hear you later.

Clearly such descriptions of working conditions enable the operators to judge there and then the notableness of the connection and the quality of the achievement of either or both parties in making it. In the current case,

an opportunity to test a new aspect of the working conditions presents itself.

During the following QSO, the two operators comment on the weather conditions on both sides.

> Arthur:[in Stockholm] Roger, Roger, thank you, thank you very much. Very nice to see you here. How is the weather in England? Here it's quite nice today. Yesterday was very bad, but today it's excellent.
>
> Bob: Aaaah, pleasant time, Arthur […] It's a bright morning, a little bit of cloud in the sky, but a very, very bright sunny morning, I can imagine at the present time, it's only early yet, I can imagine the temperature, it's gotta be around maybe six or seven plus, but I think it will improve as the day goes by. It's looking to be a very very nice day, Arthur.

This is more than idle chatter. Especially in the case of short wave, as here, weather critically relates to propagation. The enthusiasm shown by Bob about the "bright morning" with only a "little bit of cloud" is related to the excellent conditions for propagation in such weather. Indeed, such a bright morning might not be appreciated otherwise, at a temperature of only 6-7 Celsius. But such weather on a weekend morning gives the prospects for a whole day of DX work.

It should be clear by now that exchanging information about signal quality, working conditions and the weather enables Hams to reason about otherwise opaque phenomena. For example, a poor signal or one with notable artefacts can be revealed as a common or idiosyncratic problem, as due to transient conditions or an indication of a fault to be remedied, and so forth, on the basis of reasoning over what is known about signal quality, equipment and the weather, quite possibly combining information from a number of connections. Reciprocally, a good signal might be revealed as most likely due to well tuned and aligned equipment if weather conditions are poor.

In short, every connection is an opportunity to inflect the concerns of the amateur radio community and is structured accordingly. Every QSO is an occasion for reasoning and talking about radio, one's own and the community's engagement with it. Each interaction is in the face of the contingencies of propagation, accomplished through artful engagement with local working conditions, with the promise of a notable connection being made. Every connection is a test of one's equipment, any modifications one may have made to it and of one's skill as an operator.

3. Discussion

Let us return to the themes which first sparked our interest in radio amateurs. We noted that Hams are centrally concerned with *communication and social interaction*. We now know a little more about how that interaction is organised and how profound achieving and maintaining communicative relations is for radio amateurs. Communication is all of: their interest, topic, technology, their means, their end, their passion and purpose. Through the socially known-in-common organisation of a connection, problems can be identified, remedies proposed, expertise sought out. The connection can do all those things. The Polish anthropologist Malinowski distinguished informational communication (e.g. the imparting of ideas) from phatic communion (the sheer maintenance of communicative relations, the checking that channels are still open). In these terms, Ham communication is phatic-informational, or better, defies the distinction. For Bateson (1972), meta-communication is interaction where "the subject of discourse is the relationship between the speakers". In these terms, Ham talk is infra-meta-communication: the relation may be the 'subject' but it is produced from within the talk, as a natural feature of it and the technology that supports it. While we can make such glancing mentions of communication theory, they give at best partial insight, we believe, to the organisation of Ham-talk, still less do they help us understand the specifics of what Hams talk about (cables etc.).

Hams are essentially concerned with and dependent upon *technologies* to make their communications possible. However, this concern has some specific characteristics which are important to bring out. Technology is a source of (welcome) contingency and perpetual innovation. Schematics are always to be modified, improved upon, even if in a small way. Technologies are delicate in the face of bad weather, the hour of the day, and the clumsiness of drunks. We can only know of their viability, whether or not (for all practical purposes) they work, if we can test them 'on the job', in communication. Radio is a communication medium to be sure. For Hams, it is also an experimentation medium. It was pointed out that cooperative software innovations can fail if 'the work to make IT work' is excessive (Bowers 1994). However, Hams require an addendum to the analysis. For them, the work to make their technologies work *is internal to the work itself*. It is a part of the whole point of being an amateur radio operator.

The amateur radio community is *distributed world wide* but this degree of dispersal presents no essential problem of 'community maintenance'. Again, there are simple natural features of Hams' communication practices

which make it easy to see how this is the case. Seeking out long distance connections (DX) is a fundamental part of what makes listening interesting and continual technological innovation motivated. If listening for DX is an activity of continual interest, then a readily maintainable world wide network of contacts, who in turn may be valuable sources of know-how for radio affairs, comes gratis.

Amateur radio is an *enduring community*. Yet again, there are simple features of it which need to emphasised. Novices have before them a graceful learning path: from listening to transmitting, from easier to manage locally useful connection modes through to exotic methods with a long reach. At each stage though, interesting contingencies will need to be negotiated. Motivated relations between 'sub-communities' are easy to recognise and understand. Sub-communities naturally form around interests in different connection methods (VHF, short wave, EME)—these methods being at one and the same time the principal means by which interested parties will encounter each other, communicate and find out more. Radio is a durable topic (it is not going to go away) and while the accessibility of different wavebands is under continual review, there are many methods to explore and folk who will share an enthusiasm for their 'research value'. To find them, just tune in. You do not lose membership if you lose interest in just one thing.

It is interesting to reflect on the obduracy of the amateur radio community in the face of the Internet. There is no substantial sense for our informants of the Internet being a threat. It is simply *not* the communications medium *par excellence* in contrast to what some commentators (e.g. in Smith and Kollock 1999) routinely assume. For Hams, it does not present the same opportunities for innovation or the same (welcome) contingencies. Most specifically is does not present *radio related challenges*. Accordingly, many Hams make use of Internet facilities (e.g. discussion groups and websites) and allied infrastructral digital technologies (wave-LAN, Packet Radio) for what they can practically gain *as radio amateurs* from them. While there is a minority interest in using Packet Radio to make connections:

> It's as if we forgot where it all began. They should turn to 500 [145500, a call frequency] and call each other. Push the kilowatt into the antenna and see what you get […]. Nobody's giving diplomas for digi[tal communication]…

3.1 Contingency, Challenge and the Everyday Texture of Interaction

For our informants, amateur radio is a world of great contingency (experimental equipment, atmospherics, the phases of the moon in relation to a fixed antenna, or who happens to be on the wave). Negotiating these contingencies presents challenges—of an inexhaustible but not impossible sort. Challenges to continually perfect technology, to explore rare destinations, new connection modes, rare methods, less power consuming techniques: welcome contingencies, requisite mysteries and enigmas, a lifetime of challenge.

It seems to many of our informants (and their wives) that one could go on forever addressing these contingencies. In all such endeavours, the presence of community peers is essential. The Ham community is all of: a source of feedback on the quality of innovation and experimentation, a source of advice and collaboration, an audience to report successes to, with each connection serving as a 'test'. If successes are important for the whole community (e.g. the first EME connection) or for the world at large (progresses in broadcast radio, readiness for emergency), the challenge deepens and can assume the character of scientific research, public service or humanitarian mission.

In the face of this, we do not see the need to resort to any deep psychological motives or invoke major concepts from contemporary social theory to explain the appeal of the Ham community or to make sense of it as a social formation. Its constitutive concerns (radio for communication, made at home) tie together 'actionable challenges', formats for social exchange, and a form of life. The everyday texture of interaction on the airwaves inflects the community's broader concerns. Transmission quality, destination reached, working conditions are 'deep' constitutive concerns of the community but which are readable on the 'surface' of every strip of talk:

> That's mostly it, I just wanted a connection from Sighet to Medias to exist through the repeater Q five echo. Good, dear friend, I wish you all the best, happy Easter and hear you later.

3.2 Community and technology from a Ham perspective

From the perspective we are developing we can critically engage with a number of contributions to the topic of community. We fully agree with Mynatt et al. (1999) that a thorough knowledge of the community one is working with *in its specificity* is essential. For example, Mynatt et al. point

out that, contrary to much received Internet 'wisdom', SeniorNet saw a valuable and legitimate role for activities sometimes referred to as 'lurking'. Similarly, on the amateur airwaves, listening is not lurking. It is routine practice and, as a dedicated activity, it is how one learns. Knowing the organisation of radio interaction and the specifics of the medium in the hands of this community enables the researcher to critically interrogate the value of 'received' concepts or prior intuitions (cf. Mynatt et al.'s remarks that not all identities within the SeniorNet community are 'senior-like').

Urging a sensitivity to the variability of communities is not the same as arguing that one study will be without implications for others. Our field study has drawn attention to the importance of *requisite challenge* in the life of radio amateurs. We believe that this notion can be read back into much of the community computing literature. For example, many of the cases of computing initiatives defined around a shared geographical locale reviewed by Schuler (1994), also involve their members in a shared challenge whether this is to network all local schools or prevent threatened environmental damage. When these challenges are as detailed and as *inexhaustible, yet still actionable*, as those we have seen in the radio amateur context, we would suggest that understanding them and designing for them will be essential to any proposed community computing project.

The case of radio shows (communication) technology as being the source of challenge. This is of course not singular. Software technologies provide such seemingly inexhaustible spaces of contingency to open-source communities (e.g. Kollock 1999) , or hackers (Levy 1994).

Community endurance and sustainability are enigmatic topics in much of the sociological literature (cf. Smith and Kollock 1999): what makes for the durability of communities in the absence of the reward or incentive structures familiar from the world of paid employment? Following our emphasis on understanding the specificity of particular communities, we do not feel that there is a general answer to this question, rather an empirical program to pursue. However, our study of radio amateurs gives us a clue as to the kind of phenomena one should be sensitive to in addressing this matter in other contexts. A persistent feature of radio amateur life is how (let us say) *'overdetermined'* their conduct and activities are. As we have emphasised, radio communication is many things to them (their passion, their challenge-ful provocation, their means, their end). Other radio amateurs are co-interactors, collaborators, audience, often at one and the same time. Radio communication is fun but might also be research and public service. Any activity lodges itself in a whole nexus of other activities and structures of motivation, talk and reasoning. When activities are that closely interwoven, they may also be hard to undo. While the particu-

lar ways we have seen in which communication, community and technology intertwine are specific to Hams, the (let us say) *'density of mutual implication'* we have observed between activities in this context might provide us with an image for engendering and sustaining new community forms.

Other generic observations on community endurance are related to learning. The *graceful learning path* that radio amateurs can follow contributes, we believe, to many members progressing at any given time between various stages of expertise. This ensures that the community is well-populated at all work difficulty levels, with the continuous occurrence of new challenges constituting their incentive to learn more (by themselves and from others) and make progress between such difficulty levels. This model of community sustainability is further developed in (Bogdan 2003) and design is done on its basis for a community of amateur student programmers.

3.3 Challenging Design

Having expressed our specific view of community understanding as it emerges from our case, let us illustrate what our results suggest to technology design methods. Many writers on communities urge a participatory approach where innovation is a negotiated product between members and designers. A traditional argument in participatory design is that such processes are not only more acceptable for members, they also can yield higher quality products than more traditional approaches with 'imposed' innovations (Ehn 1988). If, as we suggest, understanding and designing for a community's core challenges is an important principle, then a participatory approach would carry the further implication that *design itself can be regarded as a source of challenge for participants*. That is, one should not attempt to eliminate contingencies in design in pursuit of the perfect product. Rather, one should maintain a level of (welcome) contingency and challenge in an open-ended innovation process – a process which might itself be densely interwoven into the everyday activities and communication practices of the community being engaged with. Design practices should seek out opportunities for exploring sources of contingency and challenge that are valued by members – and, if possible, valued under many different intertwined perspectives. In short, design for communities might learn by tuning in to our radio amateurs.

In our ongoing work, we are using this perspective to scope and drive design activities in collaboration with amateur and voluntary groups (Bogdan 2003). For example, a collaboration with the technical group within a

voluntary international student organisation has involved turning away from commercial technical products (e.g. the use of products such as Lotus Notes™) in favour of a design solution which offers a wider range of programming challenges to the members themselves. The platforms we have begun to introduce to this organisation allow extensive end-user programming. We do this, not so much out of antipathy towards commercial solutions *per se,* but because, in this context, this design strategy might keep valuable challenges and skills alive over the longer term, as well as encouraging self-sustainability of both the programming activity and the group pursuing it.

We do not expect all communities to be organised as profoundly around challenges as are radio amateurs or our student programmers. In such cases, design may not profit from our principles for maintaining requisite challenge. Furthermore, we do not anticipate that just any community will find satisfying challenges in computation or computer-mediation. While they inspired our perspective of 'challenging design', radio amateurs themselves (as we note) find radio and not computing challenge-ful. These observations suggest that locating the core challenges in a voluntary or amateur community might inform the scope and scale of computer-released or mediated solutions.

4. Conclusion

This paper has been concerned to present a study of radio amateurs as a perspicuous instance of an amateur community. The rationale for this is that such communities are being increasingly investigated, and our hope is that a dedicated empirical study of a prime example might help (re-)specify research on the topic. Bowers (1994) argues that a particular study can often have the upshot of 'shaping research agendas' by pointing out research opportunities we might not have thought of through theoretical or conceptual reasoning alone. This study is a similar attempt to 'learn from the field'. Accordingly, we have offered an image of a potential design practice for working with amateur communities: *design for challenge*. We have also imagined how such a practice might be sustained by drawing inspiration from features of the life of Hams which contribute to the endurance of their community: *inexhaustible challenges encountered in densely interwoven activities*. It must be admitted that, at this stage, these are speculative upshots from our work requiring further investigation and specification.

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