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Low-cost, low-bandwidth online meetings between farmers and scientists

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ABSTRACT
This paper presents aspects of a nine year research activity into the use of low-cost, low-bandwidth Information and Communications Technology (ICT) to support online meetings between farmers and scientists in rural Australia. It discusses the use of Microsoft NetMeeting™ (NM) to support these meetings, and describes the social and technical conditions under which these tools are likely to be useful and used.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation

General Terms
Management, Performance, Design, Reliability, Human Factors, Theory.

Keywords
NetMeeting, tele-collaboration, CSCW, video conferencing

1. INTRODUCTION
With Australia's vast distances, highly urbanised population on its Eastern seaboard, and shortage of services and professional talent available in many rural communities, the potential for internet based delivery over existing low-bandwidth connections using low-cost, off-the-shelf technology appears attractive.

This paper reports on the use of low-cost, low-bandwidth Information and Communications Technologies (ICT) to support meetings between agricultural scientists and groups of remote farmers. It describes experience from a longitudinal study conducted over nine years, where farmers and scientists met using NM to share and discuss the outputs of the farming systems simulator (APSIM). APSIM can be specified to simulate a range of crops, soil types, fertiliser rates and climatic conditions to allow farmers to evaluate different courses of action in the face of a variable markets and an uncertain environment.

The time and cost involved in researchers visiting farmer groups across Australia makes frequent or regular face-to-face meetings impractical and prohibitive. This research examines whether online meetings are an effective substitute for meeting face-to-face, and if so under what circumstances.

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2. BACKGROUND
During the first half of the 20th century, agriculture grew to become the largest contributor to Australia's GDP, peaking in 1951 at a 30% share (ABS, 2005). In response federal and state governments invested the concomitant and substantial tax revenues to establish and expand federal research and development agencies and state based agricultural research and extension services. This was an international phenomena- the FAO report that of 207 agricultural extension agencies in 115 countries, half were established or significantly reorganised after 1950 (Swanson, Farner, & Bahal, 1990). These agencies were designed to take the outputs of scientific activity and communicate them to farmers- with the aim of improving the yields, productivity and efficiency of those farms.

However, by the mid-50's, agriculture's share of Australia's GDP had started an inexorable and consistent decline, which by the 1980's had accelerated to between 4%-5% per year (ABS, 2005). In 2001 the contribution of agriculture to Australia's GDP was 3.7% (ABS, 2005). As a result of this decline, federal and state governments have progressively disinvested in agricultural research and extension.

In response to this decline in investment, research and extension agencies, governments and the public became increasingly conscious of both the efficiency and effectiveness of research and extension. This provided strong motivation to better understand the different ways for farmers, and in turn broader society, to achieve the greatest practical return from scientific progress in agriculture.

Different countries have responded differently to these changes: from a programme of radical restructuring and revitalisation at the United States Cooperative Extension Services, to complete privatisation of New Zealand' s Ministry of Agriculture and Fisheries' advisory service (Hercus, 1991). In Australia the general trends have been to drastically reduce extension staff numbers, limit free advice, and to introduce user-pay and cost-recovery models.

Another important response was the introduction of computer based decision support systems and expert systems as a way of reducing the need for human extension agents. The promise of increased efficiency, reliability, availability, comprehensiveness and accuracy of software systems designed to support farmer decision making, when compared to the average human is, on the face of it, extremely compelling.

The successes and failures of such systems in agriculture in many ways mirror the experiences of using such systems in the context of large organisations. In short, there emerged a massive gap between the promise of such systems to provide timely, relevant, usable information and their actual use and value. After many years of investment in design and development by several international agricultural research agencies, there were very few examples of farmers actually using these systems in any meaningful or sustained way (McCown 2001).

In 1991 a group of agricultural scientists from the CSIRO, who had just been relocated to Toowoomba in South East Queensland, became intensely interested in why such systems were not more widely used. The group embarked on a series of research activities to understand why there was so little interest in such systems, and if there were any circumstances under which they could in fact be valued.

By the end of 1998 internal and external evaluation of this research effort indicated that this activity, now collectively known as FARMSCAPE (Carberry 2002), had created significant market demand for access to computer based system simulation as a tool to aid farmer decision-making. Demand for FARMSCAPE tools and services was exceeding the team's capacity to deliver, and in one year, over 100 simulation scenarios were conducted and delivered (Carberry, 2002).

This groups approach involved taking sophisticated simulation of farm production systems directly to farmers. This involved a scientist driving to a farmers property, and sitting with a group of between five and ten farmers, and then specifying and running the simulation in response to scenarios that they would develop. Typically these scenarios would involve different planting dates, different rates of fertiliser (usually nitrogen), different crops, or availability of water- among many others. Given strong demand for such sessions, the next research question concerned how to deliver these sessions to farmers in an efficient and sustainable way. Meeting face-to-face was costly in terms of time and travel- the challenge of this research was to ascertain if meeting online was either a feasible, or practical alternative to face-to-face meetings with farmers.

3. METHODOLOGY

This research drew on the theory of *systems thinking,* as a way to engage with and conceptualise the problem domain. A systems approach is particularly well suited to messy situations, where relationships between parts of the system may be unknown or are at least unclear at the outset (Checkland, 2000). Systems thinking attempts to understand the different parts of a system in relation to each other, as a whole and against other systems. Systems theory was not used in a prescriptive manner, but rather as a guide to framing the research, and engaging in the problem setting.

This research draws on the theory and practice of Participatory Action (PAR) as a way to structure the research process, broadly following sequential cycles of: planning a research intervention, acting in the problem setting, observing and collecting data, and critically reflecting on the experience as preparation for subsequent research interventions (Dick, 2002; Checkland & Hollwell 1998). PAR is a dynamic and collaborative approach that involves the researcher acting as a participant in the problem setting, while monitoring and evaluating the effects of the researchers actions. PAR attempts to both understand the problem setting, and to create change in the problem setting based on learning, and critical reflection (Dick, 2002; Checkland & Hollwell 1998).

Over the course of this longitudinal study, and within each PAR research cycle, design ethnography provided a set of methods to gain insight into the phenomena of online farmer-scientist meetings. These included participant observation during an online meeting, semi-structured interviews and informal conversations with farmers and scientists, in depth interviews with participants, and a case study approach to structure reporting.

3.1 Methods

This research was conducted using the following PAR process: 1. recruit participant farmers; 2. negotiate individual projects with farmers; 3. provide training to farmers in using NM; 4. online meeting between farmers and scientists to elicit farmer questions and scenarios; 5. researchers specify and run ASPIM scenarios; 6. online meeting between farmer and scientists to discuss APSIM output; 7. principle researcher to document observations from meetings, and any changes in farmer action as a result; 8. evaluate research practices and process; 9. loop to 1 or 2.

We undertook 15 Internet meetings with farmers from seven groups across Australia, including- Moonie and Bongeen (South East Queensland); Walgett (Northern New South Wales), Brim and Birchip (Northern Victoria); Liebe and MIG (Western Australia). The primary researcher was present at the farmer meetings to both observe, video record the sessions and act as technical support. We collected data by video recording meetings, where possible at both the farmer and researcher ends, using a mix of pre and post-workshop questionnaires, participant evaluation, and conducting post-workshop farmer and researcher interviews. We additionally undertook periodic longitudinal evaluations, which involved interviewing project participants in order to assess impact (if any) on farmer intentions, thinking and practice. We have selected one of these, the Moonie group, to illustrate the characteristics of a typical online meting. We used Video Interaction Analysis (VIA) (Jordan and Henderson 1995) to analyse the video data. We made eight video recordings of four separate farmer groups over a period of two years (2000 – 2002).

4. CASE STUDY: MOONIE FARMERS

Moonie is a small farming community about 330 km west of Brisbane and is located in a highly climatically variable cropping zone. Moonie consists of a service station, a few houses, a motel, and a community access centre. Farming in this region has traditionally relied on wheat and cattle. For each of the online meetings between Moonie farmers and CSIRO scientists, a telephone call was established between a farmer's house, where local farmers typically met, and the researchers in Toowoomba- with both sites using conference telephones. Scientists would share APSIM outputs, created using Excel™ spreadsheets and PowerPoint™, using NM's application sharing feature. Available bandwidths were low, typically less than 48 kbs, and Internet connections would occasionally be unreliable. The following section describes one of these online meetings in some detail.

4.1 Moonie online meeting

The meeting used for this case study took place on 6 October 2000 and was the fourth meeting in a series of six. Participants were spread across two sites, the researcher's (R1's) office in Toowoomba, and a farmers house (MF5) in Moonie. In Moonie, 8 farmers (MF1 – MF8) were seated in a semicircle around a conference phone and facing a laptop with an external monitor attached, showing various graphs via NM, shared by R1 (see the seating plan shown in Figure 4). In addition, a member of the FARMSCAPE team (RTS) acted as technical support and also captured the meeting on video. In Toowoomba, R1 presented the simulation results as Excel graphs to the farmers via NM, and also acted as facilitator. R1 was sometimes joined by another technical support person, RTS2, who helped solve several technical problems during the meeting.

The focus of this meeting was a discussion of the performance of various crops, including gross margins, compared to their potential environmental impact.

What stands out from VIA of this meeting is the way farmers and researchers *repair* frequent technical and social *breakdown*. VIA revealed several facilitation, group interaction, and knowledge & information issues resulting from technology breakdowns

For example, graphs would sometimes appear truncated or be delayed for up to 30 seconds before they were displayed to farmers- due to slow or unreliable connections. In such cases, the researcher, unaware of the problem, would often start explaining the graph and the farmers would have to stop him, or listen take notes and ask questions when the graph finally appeared.

This session, unlike later sessions did not feature video. Due to variable quality audio, the remote researcher facilitator reported that he had felt 'disconnected' from the farmers – he later commented, "it was like trying to chair a meeting with your eyes closed" (Hargreaves and Keathers 2004). A side effect of this lack of (visual) feedback for R1 was a very passive style of facilitation. However, the farmers often used these enforced breaks to have animated discussions about what they had heard, and attempt to explain issues to each other.

Through successive cycles of PAR, the technical issues were progressively overcome or their effects ameliorated through introduction of new technology or procedures (eg checking that screen resolutions are the same at both ends, and that the entire graph can be seen by farmers before discussing it's content) The internet connection issues were resolved by using a modem that was able to monitor the variable impedance of the telephone lines, and adapt to keep an optimal connection- this prevented modem disconnection's. Audio was subsequently improved by using high-quality conference phones. VIA undertaken of later meetings with farmers at Walgett, Liebe and MIG, after further PAR cycles show that most of these issues had been overcome.

5. FINDINGS & DISCUSSION

The following section presents learning's drawn from this research about the nature of online meetings, and the conditions under which they can be valued.

1. Participants need sufficient motivation to both participate in the meeting and to endure technical issues with online meetings. Motivation is raised by both Olson and Olson (2000) and Dourish (1996) as a key feature of success: "Motivation has been established as one of the major sources of failure in adoption of groupware in general".

Motivations can take many forms. One farmer indicated that the potential for the technology to reduce the remoteness and isolation of rural life was a significant motivator for continued participation.

"One of the boys had a motorbike accident and I could attend that and come back (My wife was working). Without the technology I would not have been there. This technology helps to break rural isolation." (Birchip Farmer, 2003)

2. A productive online meeting requires both an effective social space, and work space (see Fig 1). An effective social setting provides the conditions for affective expression, open communication and group cohesion to naturally develop (Garrison 2007)

During face-to-face meetings farmers often supplied food and drink to the researchers before and after the meeting. This provided an opportunity for informal small-talk and discussion that had the effect of maintaining good social relationships. It was noticed that online meetings provided fewer opportunities for social discussion.

An effective social space can encourage social presence, which is an ability for learners to project themselves socially and emotionally, and hence be perceived as 'real people' (Garrison 2007). There appears to be a strong correlation between a sense of social presence and learning outcomes in the work space. It is therefore important that the research facilitator take specific action to encourage a good social environment, including the appropriate use of small-talk, humour and displaying personal interest in farmers families or other non-work related issues.

3. A good social space can contribute to developing social scaffolding. Well functioning social relationships have the effect of scaffolding the substantive work of a meeting (Nardi 2002). Farmers often indicated 'knowing' the researchers was important when interacting online. One farmer suggested that they, "Felt comfortable [meeting online], especially seeing we knew them [researchers], and what they are on about; it might not be quite as easy if we went in cold, not knowing them." (Birchip Farmer, 2001)

In an interview with a farmer [BF1] from the Bongeen group the question was posed, "Is the online meeting as good as the face-to-face meeting?" The farmer replied "No… it is far better, because we can get more frequent access to you guys and it eliminates travel." He then added "… as long as we can get together with you guys once or twice a year, maybe at x-mas for a beer or something, like we do with our fertiliser guys." The role of informal events such as barbecues and morning and afternoon tea are important in terms of creating effective social fields and bonds that then scaffold future interaction. Video provided a way to engage in more informal communication, thereby providing opportunities for creating social fields.

4. An effective social space was a necessary condition for a productive and efficient work space. An effective work space allow for the substantive issues on the agenda to be completed in an efficient, accurate, professional way. The work space needs to be well facilitated, have a well organised agenda, and have procedures for when the technology fails. A good work space provides an environment that encourages learning, and effective discussion of newly introduced concepts and ideas.

5. Effective facilitation was central to developing good social scaffolding and an effective social space, and also ensures the meeting was conducted in a productive and efficient way. It was observed that a well-respected locally based farmer facilitator or co-ordinator plays a central role in developing common ground between farmers and researchers "We do need a facilitator (who) needs to know the persons at the other end so that they are comfortable, talk freely, cut them off if necessary, make it flow better. The facilitator also needs to know us…" (Brim Farmer, 2003)

6. Collaboration technology readiness- farmers need to be capable of fixing basic technical problems themselves, without local technical support. The farmers we worked with all displayed displayed a willingness and ability to learn basic technical skills. The FARMSCAPE team provided the Moonie group with a high level of technical support and training leading up to and during on online meeting. This effectively alleviated the need for technical skill and knowledge in the use of NM.

Additionally the farmers over time became more skilled in and attuned to the use of and performance of the technology. For example, when the research facilitator at Moonie consistently 'scrolled' the graphs a farmer commented: "Stop scrolling… it causes scribble over the screen…" [M2F].

7. The technical aspects of the meeting needs to be reliable and well functioning. There need to be robust procedures in place for times that the technology fails. Robust procedures allow the meeting to continue even if the internet connection fails. An example of such a procedure includes having printed materials on hand, having the researcher know when the connection has failed so that they can let the farmers know, and make seamless, corrective action.

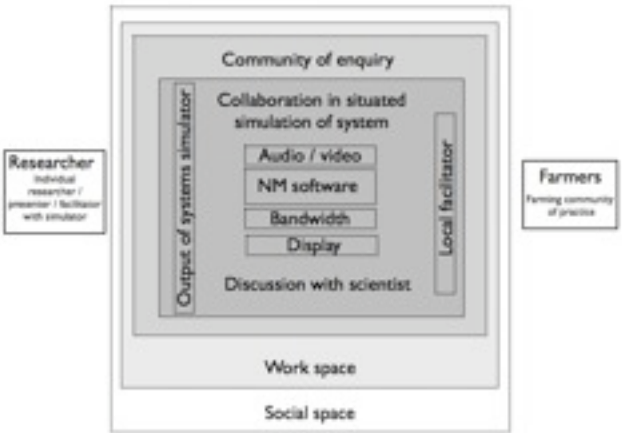

Figure 1. Schema of an online farmer-scientist meeting.

8. The offline interaction and preparation that precedes a meeting is essential to an effective and well run meeting. During the weeks leading up to an online meeting there would typically be a series of interactions via phone, email, fax, and visits by technical field staff. Activities include: i) farmers sending weather and soil to the researchers- usually via email or fax; ii) researchers would then negotiate with the farmers about the simulation runs to undertake (eg range of planting dates, range of fertiliser rates, combination of crops etc); iii) researchers would run the simulations and check the results with either the local facilitator / convenor or a lead farmer- as a result the simulations may then be further localised, and; iv) the simulations are then presented back to the farmer group using NM.

Olson and Olson (2000) characterise an aspect of work they term *coupling*. "Tightly coupled work… typically requires frequent, complex communication among the group members, with short feedback loops and multiple streams of information. In contrast, loosely coupled work has fewer dependencies or is more routine. […] In loosely coupled work, there is common ground about the task goal and procedure; it merely needs to be played out. Loosely coupled work requires either less frequent or less complicated interactions".

6. CONCLUSION

This research demonstrates that online meetings using low-cost, off the shelf ICT, and low-bandwidth internet connections are feasible, effective, valued by farmers, and can be an effective substitute for face-to face meetings- as long as certain criteria are met. For an online farmer meeting to be successful, an effective effective social space, and effective work space should be developed; there should be effective local facilitation at the farmer site; and farmer participants must have sufficient motivate to participate. The contribution of this research is a rich longitudinal study of online meetings between farmers and scientists, and the concomitant learning's about the conditions under which online meets can be successful.

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