Homeonics and No. 8 Wire Research

Michel Jouvernaux
School of Information Technology
Waikato Institute of Technology
Michel.Jouvernaux@wintec.ac.nz

Abstract

An attempt by staff members at developing a research theme for a Faculty School endeavours to bring consensus by encompassing the varied interests of research staff. Intelligent Home, Ubiquitous Computing and the Disappearing Computer are three current topics of Information Technology and Computer Science which are drawn from to set up a suitable research theme for the School; this new theme is baptised "*Homeonics*". The adaptation of the three topics to ITP research entails the creation of a research methodology based on the Design Science alternative research paradigm and incorporating the time-honoured NZ tradition of "No. 8 Wire" inventions. The contention expressed is that *No. 8 Wire Research* is a good fit for ITP research as it can involve all levels of teaching and non-teaching staff and students. A research project already well advanced is given as an example of the various concepts in actual practice.

Keywords: Intelligent Home, Ubiquitous Computing, Disappearing Computers, ITP Research, Homeonics

1 Introduction

Officially at least, research in the New Zealand Institute of Technology and Polytechnics (ITP) sector is relatively recent, since the introduction of undergraduate Degree programmes by those institutions, and spans a couple of decades at best. Although ITPs cannot claim the long research tradition of universities, the culture of research there is nevertheless starting to gain momentum and more importantly develop its own cachet. The different approach taken to research by some ITP staff often delivers very worthwhile results indeed. ITP research is not merely complementary to other research institutions, it provides outcomes that probably would not be arrived at by more traditional research, and that is a good thing.

Staffs of the School of Information Technology at the Waikato Institute of Technology have for a while attempted to devise an inclusive research strategy and theme. This move was started top-down by faculty management; a few options were evaluated but as yet no consensus has emerged with staff willing to "buy in" in a particular research theme.

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It is likely that the narrow characterization of most themes offered so far felt too much like a "strait-jacket" and deterred researchers from committing to any. To complicate matters, most ITP research seems to take place in fragmented time and with scarce resources. Nevertheless a culture of research is alive and well at the School of IT; however the diversity of research projects is hard to bring together under a single theme. This paper describes the "bottom-up" process followed by staff members developing a research theme for the School: one that is believed most suitable and which will hopefully gain long term support from staff.

2 Research Issues

The challenge thus remained to develop a research theme that would generate collective enthusiasm and create synergies while acknowledging the importance of researchers' individual curiosity as a prime motivator and genitor of ideas. The establishment of a new research theme naturally leads to much pondering: it has to be specific enough to offer cohesion to the body of researchers, yet flexible enough to have the ability to encompass and demonstrate the wide range of skills, interests and talents present among staff and also students. The primary goals are to support teaching and meet PBRF requirements, and at the same time the need for professional recognition and possible rewards for IP outputs weigh equally high among staff motivation.

As a starting point to achieving these goal, some of the topical issues in Information Technology and Computer Science today were examined; there was a desire to be doing something new and interesting, aligned with today's currents of thinking in the IT industry, while tailoring it back to a realistic proposition for ITP researchers to get their heads around and produce sensible outputs. A good fit to staff's interests and capabilities was found with the topic of the *Intelligent Home*. Closely underlying *Intelligent Home* research are other important computer science developments around *Ubiquitous Computing* and the *Disappearing Computer* (Streitz and Nixon, 2005). These areas currently receive much attention and perhaps more importantly much funding overseas (The Disappearing Computer Initiative, 2003); all three are certainly complementary and could be considered separate prongs of a prevalent desire in today's researchers to finally bring technology to the service of humankind, in a world where it all too often feels the other way round.

2.1 Intelligent Home Research

The phrase "*Intelligent Home*" refers to a house where technology is used extensively to make the lives of its inhabitants easier and richer in many ways. By extension the title is being applied to academic research that is being conducted on this topic, typically involving a lot of resources at prestigious institutions, for example, MIT's PlaceLab project (MIT, 2006). PlaceLab is, however, mostly about measuring and understanding how people interact with their living spaces, and the emphasis is on architectural solutions; this is a very worthwhile goal in itself, but largely precludes retrofitting to existing houses. Another interesting project is the Aware Home Research Initiative at the Georgia Institute of Technology in Atlanta USA (GIT, 2000-2004) which has a much more practical approach to solving everyday problems using technology; those ideas are yet to appear in concrete form on our kitchen benches or elsewhere in our homes. Companies, typically appliance manufacturers, equally profess to wanting to improve our everyday lives - e.g. Electrolux and "The Thoughtful Home" (Electrolux, 2006) - their goal is really to make people consume more, and the approach typically falls very short of being holistic, with much marketing of the "razor-blade" kind. There is little available on the open market, and the appliances for the Intelligent Home are only dimly on the horizon, seemingly never getting closer.

One recurring tenet of current thinking in "Intelligent Home" research is the concept of "Ambient Intelligence" (Nigel, 2003). This assumes that the functions of the "Intelligent Home" require Artificial Intelligence (AI) and awareness to be workable. The painfully slow progress made by Artificial Intelligence research could thus be the single chief reason why technology use in our lives and homes in the 21st century is not as pervasive or plain useful as we imagined it a few decades earlier (Jouvernaux, 2006). In the famous words of Paul Valery (*1871–1945 French poet, essayist, and philosopher*), "*The trouble with our times is that the future is not what it used to be*".

2.2 Homeonics

The looming question is whether the world really needs to wait for AI to benefit from the advantages of a technologically savvy home. Do people really want a house to be smarter than them anyway? In fact, there is a long tradition in literature and movies of people disliking or being threatened by artificial intelligence: from HAL in *2001 A Space Odyssey* to SkyNet in the *Terminator* movies. In fact, a most believable reaction to "intelligent" technology is Dave Lister's dealings with Eddie the Toaster in *Red Dwarf*: he just takes to it with a big hammer! However, regardless of the need for acceptance of AI in the home, there is much potential for applied research within the many subsystems that need to be designed, developed, built and put together for the 21st century home. The scope for useful and topical research and design work on specific widgets and technologies of the Intelligent Home is simply boundless. Especially if including the creation of technology that can be retrofitted to existing homes and the development of technology that "agrees" with the kiwi lifestyle. Without the need to wait for AI to bloom, a "fake" brain developed with good processes and clever programming could deliver most of the functionality that people really want today. If done well, then whenever - and if - the mythical AI "brain" finally arrives, it should be able to integrate with and enhance most of the control systems that already sense and operate the house.

Another important consideration was the pragmatic necessity to bring those elaborate AI concepts to a level accessible to ITP research; coupled with the desire to take a step back from the "Intelligent Home" research label, a different approach was devised resulting in the creation of a new term -*Homeonics*- used for defining the area of research believed suitable for our School with available skills and resources. In fact this term was apparently accidentally coined by the research team; although there is some vague recollection of having heard it somewhere before, no search of the Internet of academic databases could find any trace of the word. The confusion may arise from the similar sounding word "*humionics*" which has a different meaning entirely (if not so far away) and relates to wearable computing (Humionics Society, 1998). So in the meantime, and until anyone else comes with a better and prior claim to its use, "*homeonics*" will be used herein with the hallmarks of ownership; as such it will carry a specific definition: the coming together of existing electronics and information technology hardware and software to enhance the capability of everyday home. The goal of homeonics is to improve the usability, efficiency and enjoyment of the homes we all live in using a low-key, low-budget and practical approach to widget development. Note that "intelligence" is no longer required! Homeonics has potential to relate to many aspects of home functionality: e.g. entertainment, energy efficiency, security (see Fig. 1). The bonus of the Homeonics research theme for an ITP school is that researchers all have a vested interest in the outcomes - everyone has a home! Homeonics research is also inherently multidisciplinary and offers something for everyone. In IT alone, it can involve networks, software development, data exchange, databases, security, robotics, embedded logic circuits, and possibly many others. This can let staff pursue a research project within their specialties and satisfy their curiosity, while still fitting under the Homeonics Theme umbrella.

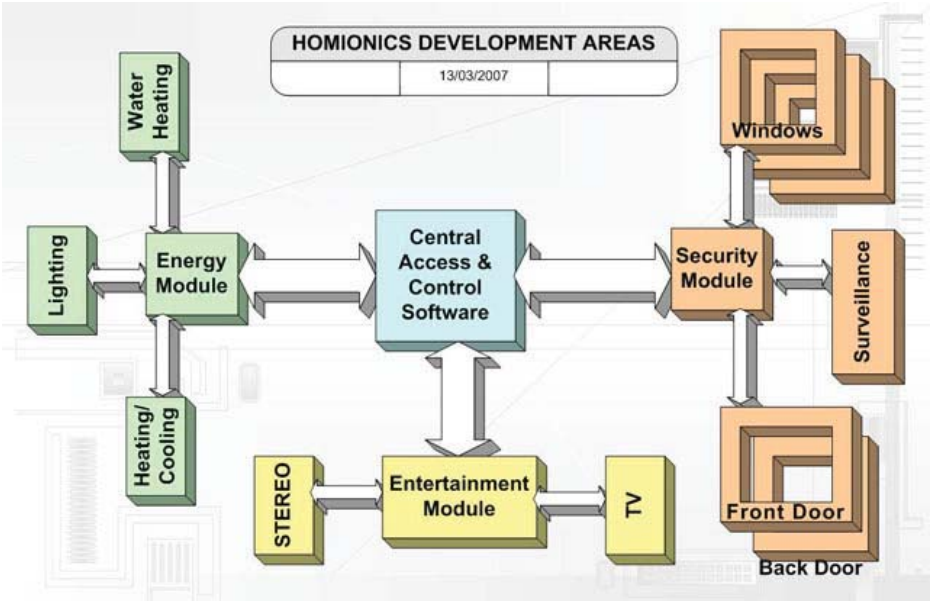

Figure 1: Homeonics Development Areas

To summarise, the main objective of the Homeonics Theme involves the development of hardware gadgets for the home. This is also about democratisation of technology: there is a firm intention to create practical and affordable technology that can be sold shrink-wrapped in hardware stores. There is no denying a few existing gadgets and software already on the market, nor the existence of some in-house systems custom-built by enlightened amateurs. Major points of difference for homeonics projects are the application of clean, simple design rules, a comprehensive effort to use open or public standards to ensure interoperability, and an open quality control and review system involving as many stakeholders as possible. This will be achieved by using a flexible research approach based on strong foundations.

2.3 No. 8 Wire Research

In New Zealand culture, "No. 8 Wire" refers to a type of metal fencing wire used by ingenious farmers for many other purposes than the intended. The expression has entered the colloquial language to describe any useful contraption devised by backyard inventors. Historically, this includes the electric fence, the jet boat, bungy jumping and a multitude of other inventions of lesser fame. By extension, it is used in this paper to describe a particular research philosophy dubbed "No. 8 Wire research" (Jouvernaux and Rajendran, 2006). In a nutshell, the No. 8 Wire approach is the creation of new devices or outcomes by the use and composition of existing technologies and devices in an original and novel way, in the time-honoured kiwi tradition of No.8 Wire developments. Although some believe that this approach to research, design and development is an outdated romantic notion (Devereux, 2005), the fact remains that its contribution to the New Zealand culture and also the economy cannot be denied. Although No. 8 Wire Research is not tied down to any particular methodology and intentionally leaves space for intuition and instinct, this should not be mistaken for a spurning of method; it is quite clear that most successful No. 8 Wire inventors had a "system". The grounding of the No. 8 Wire Research concept is in fact in Design Science. Design Science is an alternative to the Objectivist or Interpretive paradigms, although not necessarily exclusive of either. Design Science has a particular focus on problem solving and can be applied to the improvement of engineering practice (Hubka and Eder, 1996), so it is well suited to engineering disciplines, including software engineering (Myers, 1997). Design Science allows the researcher to use qualitative methods to discover the needs and requirements of the intended audience for a particular problem and then proceed to create an artefact and offer it as a solution to that problem (Mommsen-Ghosh, 2004). In an Information Technology (IT) context, Design Science is applied research that offers tangible outcomes. The Design Science research process generally comes from tenets and literature in engineering disciplines, and can be adapted readily to Information Systems (IS) research. The two-phase six-step process (Fig. 2) devised for No. 8 Wire Research has been somewhat adapted from others proposed by Peffers et al (2005) and Vaishnavi & Kuechler (2006). First comes a requirements analysis phase which includes three steps:

- Step 1, *Define intended audience* or who will benefit from the research output? Who are the stakeholders?
- Step 2, *Define Problem Area* or what are we trying to fix or improve? What's the problem? This hinges on stakeholders involvement to determine the scope and boundaries of the research project.

- Step 3, *Find Needs and Requirements* or what can or must be done to solve the problem? In practice, this culminates in paper design leading to the building of prototypes in the second phase.

Anyone familiar with the software engineering process will find all this quite familiar. The completion of Phase 1 leads into Phase 2; the second phase is a build, implement and review phase and also has three steps:

- Step 4, *Create Artefacts or Models to Solve Problems* or the building stage. This normally includes the creation of several solutions using alternative designs and technology.
- Step 5, *Offer Models and Artefacts as Solutions* sees the implementation and delivery of the created solutions to a sample of the target audience identified in step 1.
- Step 6, *Evaluate and Monitor Success of Solutions*, is a review and learn exercise the outcome of which - if not entirely satisfactory - may lead to a project re-entry at Step 3 or Step 4.

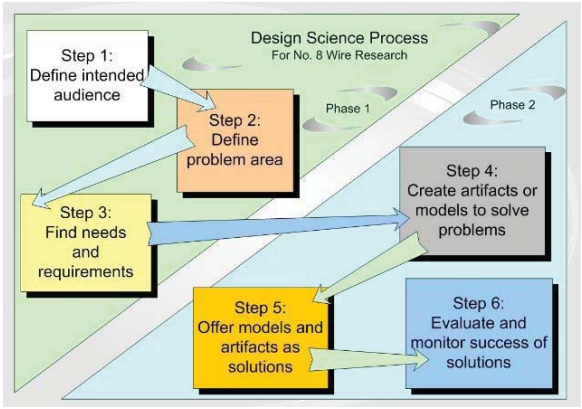

Figure 2: Design Science Process for No. 8 Wire Research

Each step, but in particular Step 2, 3 and 6, involve the application of qualitative research techniques for their completion (e.g. semi-structured interviews and participant observation). Quantitative approaches like surveys can also be useful in Steps 2 and 6.

2.4 Leveraging ITP Strengths

There are, no doubt, many existing products and gadgets that can be incorporated in the home, and many more still requiring to be designed, prototyped and patented. Importantly, any homeonic technology which wants to be useful to mankind must be able to be retrofitted to existing housing; otherwise the benefits - and the market size - are greatly restricted. Homeonics systems research and design, if done this way, has unquestionably a very lucrative potential, and any Intellectual Property derived from it will be welcomed by cash strapped ITPs often poor cousins to universities. Yet there are other factors which boost the contention expressed here is that ITPs have a natural edge when engaging in this kind of research: for example the fact that the entire breadth of skills required is found in most ITPs: builders, carpenters, electricians, plumbers, draughtsmen, etc… Sadly, this entire body of wisdom has been largely neglected in research of any kind, yet there are many experienced professional tradesmen whose collective knowledge and "tricks of the trade" are invaluable for overcoming the hurdles of homeonics research. No. 8 Wire Research relies on ad-hoc co-operation of various staff (for example getting advice from a carpenter when designing a door frame). This co-operation in general need not be onerous: people are quite willing to give 10 minutes of their time when approached informally for advice; many staff and people in the wider community do voluntary help; this is one area this particular research approach wishes to tap into with recognition of course being given where due. In an ITP setting, this can have the tremendous benefit of involving staff in research who previously would have not had the time to contribute, or who would have believed they had nothing to contribute.

2.5 Research that Supports Teaching

Many efforts have been directed at incorporating Information Technology into the teaching and learning of science and engineering disciplines. Various approaches have been developed to that effect, generally with great success (Scanlon and Holliman, 2004). In a sense, what is advocated here is the mirror approach: where the teaching of Information Technology is enriched by the use of engineering projects. This can be especially effective in an ITP setting where students often demonstrate a preference for kinetic learning. Generating enthusiasm for learning in students is more than half the battle, and well known to be crucial to their success (Panayi et al., 2004); new strategies need to be developed to achieve that aim. With No. 8 Wire Research, students can get involved directly in the projects and subprojects of the research theme. The benefit of hands-on experience and learning by doing is well established (Carlson and Sullivan, 1999), and indeed commonplace practice for the students at this School. This can take the form of an actual student project on the third year of an IT degree, where a student or a group of students collaborate with a staff researcher towards some definite outputs; they may act in the role of research assistants or even manage their own project with its own set of research questions. Student involvement however can be of a simpler and more teaching-related nature. Experiments or actual gadgets developed by the research team during the course of the research project can be used in class workshops to demonstrate a particular application of technologies; for example, the programming of a Bluetooth receiver and its operation can be shown in action.

3 The Project

It all fits together. We have the skills, the ideas, the potential: how do we get started? The best approach as always is one step at a time. There are issues of communication, team building, human network connections to be made, etc… which require a clear focus, best provided by a specific and narrowly defined project. So to put the concept of No. 8 Wire Research to

work, and make progress with the Homeonics Theme, all that was needed was a project with a clear, concise and tangible output: it was decided to focus attention on the common and humble front door (*Porta domus*). Wishing to bring our homes' entrances squarely into the 21st century, a conscious decision was made to develop a fully automatic and secure external door. The design brief states that it must be:

- Able to be retrofitted to existing homes
- Totally hands-free. That is operates from a 3m distance without any required effort from the user
- Safe. If the door hits an obstacle or encounters resistance, it must stop where it is.
- Secure. It must open only for authorised persons, and be resistant to forced entry (as much as a current standard front door).
- Inconspicuous. Mechanism is totally hidden and blends in with any style and look, and also does not provide a target for thieves or vandals.

The front door project is currently in its early stages and is making progress. The door device/module has been chosen as the beginning step of the project because its very realisation introduces mechanical, electronic and software problems, the solving of which will put the research team on a good footing for further modules. Embedded in this research is the parallel investigation of Radio Frequency Identification (RFID) and Bluetooth technologies for the purpose of access control and security; these emerging technologies may or may not be suitable for the purpose, but the in-depth knowledge gained by staff during the course of the project will be very valuable to current and future teaching. The front door is thus the first one in a line of many homeonics devices to be developed sometimes sequentially sometimes in parallel. A rule is that each homeonics device should be able to operate independently, while conforming to a standard communication and control protocol which will enable centralised and/or remote control from a software program also to be written for this project. So it is clear that although Homeonics has nothing to do with "Intelligence" in the AI sense; it can nevertheless be pretty smart!

Once the door module is nearing completion, the next step of this research is the development of the control software for homeonics modules. Planning for this will be ongoing during the original development, with the door design keeping in mind this requirement. Design brief states that this software must:

- Work on a home computer/PC
- Allow secure remote access
- Make use of multiple Human-Computer Interface (HCI); e.g. traditional mouse/keyboard, touch screen, and voice commands.
- Conform to public open standards and good software engineering practice
- Be platform independent, i.e. work on MS Windows, Mac OSX and Linux (likely written in JAVA)

In parallel to control software development, another task is the porting of homeonics technology - based on what was learned from the front door - to other doors and windows around the home. A primary objective for doing this is the idea of offering "lock-down" of the house from a central point; that is have all doors and windows of a dwelling secured with one easy command, a process that can likely also be automated. Anyone who woke up to find they forgot to lock the front door will understand the practicality, usefulness and peace of mind that such a feature would bring. The author's home for example has six doors and two teenagers, a combination that makes the idea of "lock-down" very attractive.

Yet further work on this project will involve the investigation of other possible modules (e.g. lighting, security, energy efficiency, entertainment, communication, etc…). The potential for new homeonics applications seems limitless. Since this first project is a de-facto team building exercise and a proving ground for the No. 8 Wire Research concept, it was decided that one member of the research team would act as an embedded researcher for the purpose of evaluating the dynamics of No. 8 Wire Research; in that role, this team member will in fact conduct research on the research project itself.

4 Conclusion

The development of a new research theme for Wintec's School of IT has in itself been an interesting intellectual exercise. The result was the creation and definition of the Homeonics research theme, being the development and integration of engineering with computers and electronic hardware and software with the goal of enhancing the habitability and usability of human dwellings. Equally important was the need for a unique research methodology that would both suit the fragmented conduct of research typical in ITPs and support the engineering requirements of homeonics research: the No. 8 Wire Research concept was derived from Design Science for this purpose and offers unique opportunities to involve all strata of staff in the ITP's research culture.

An actual project team has been enthusiastically put together and a first step project has been launched to "test the water" of Homeonics research. The "smart front door" project is progressing well and is currently at step 3 of the first phase of the No. 8 Wire process (Fig. 2). Further papers can be expected which will not only report on the smart front door project outcomes (step 6) and other Homeonics projects started since, but also on the actual practice and eventual refining of the No. 8 Wire Research methodology. Watch this space!

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