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## A Design Research Journey

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## Accepted Manuscript

### A Design Research Journey

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### Abstract:

Text

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[Department statements, if appropriate, will be added by the editors. Teaching cases and panel reports will have a statement, which is also added by the editors.]

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This manuscript underwent [editorial/peer] review. It was received xx/xx/20xx and was with the authors for XX months for XX revisions. [firstname lastname] served as Associate Editor.] or The Associate Editor chose to remain anonymous.]

## 1 Preamble

Nowadays I enjoy a relaxed lifestyle in an attractive small country town in south east Queensland, Australia. I spent most of my first ten years happily in Bowen, a small town in tropical north Queensland, where life was so relaxed that wearing shoes to school was optional for many students. It seems I have come almost full circle. What has happened in the intervening six decades and is it really of any interest to anyone?

There are several reasons for my response to the kind invitation by the editors of the History Department of the *Communications of the Association for IS* to give an account of my working life. These reasons are apart from the chance that anyone may be interested in stories of punched cards and computers that were once at least as big as semi-trailers. The primary reason is that reflections on an individual's history can shed some light on the direction their career took and why they produced the work they did. At a recent seminar on design science with doctoral students, the participants showed interest in the creative and imaginative aspect of design science. They wanted to know how scientists came up with new and interesting ideas. These insights are not something that are necessarily encouraged in the writing of scientific publications, but can be seen in the occasional reflective work that appears (e.g. Weber 1997), or specialist studies of the ideas of individual scientists and their theories (e.g. Smith and Hitt 2005). A second reason is that I have not had a traditional academic career, but finished my PhD in my mid-forties after following various other pursuits. My story may provide some encouragement for others who are similarly placed. A third reason is that writing this personal account provides an opportunity to acknowledge the generosity of a number of individuals who have made a difference to my life at key points. I have had a very fortunate life on the whole, benefitting from having lived in a country and at a time that has provided good opportunities. Also, I have been lucky with my family, colleagues, students and others who have made a difference to what has been possible.

On occasion you meet an old friend who has not been met up with for years and you find that you can easily fall into the same friendship you had before, perhaps since early school days. The person is still at core the same person, with similar interests and values, just grown older. Some of my enduring core interests, coupled with favourable circumstances at particular times, can be linked to the work in design research and the philosophy of technology for which I appear to be best known. My core interests that are relevant are in art, design and literature on the one hand and on the other hand in how people think and know things, as in psychology and philosophy.

Design research refers to the form of science that concerns the development of knowledge of how things (artifacts) can or should be constructed to achieve desired goals<sup>1</sup>. This type of knowledge is “how to” rather than the “what is” knowledge in other branches of science<sup>2</sup>. Examples are the knowledge of how to build human-computer interfaces that are easy to use and lessen input errors, or the design principles behind the building of relational databases, or guidelines on how to involve users in systems development. I have a very strong belief that it is absolutely vital to consider how knowledge of this type can best be accumulated, shared and put into use, in order that information technology (IT) be used as far as possible to advance human well-being and avoid the potential for possibly disastrous ill-effects. The potential for negative outcomes is, of course, only increasing as the usage and applications of IT grow, particularly with respect to the increasing use of artificial intelligence<sup>3</sup>.

## 2 Early Education

I was fortunate to grow up in a family where books were always around and trips to the library were encouraged. In my teenage years I ran through many of the classics in nineteenth and twentieth century literature and favourite authors were Somerset Maugham and Guy de Maupassant. Near the end of high school, I discovered Simone de Beauvoir, who has remained a strong influence – not so much because of her work on feminism, but because she showed through her volumes of autobiography how a woman could support herself and have independence. Some of the ideas behind French existentialism have also

<sup>1</sup> For example, see Maedche et al (2021)

<sup>2</sup> A seminal reference is Herbert Simon's “Sciences of the Artificial”, first published in 1996.

<sup>3</sup>Current discussion of these issues by the Human-Centred AI Group, moderated by Ben Shneiderman and Mengnan Du, can be found at: <https://hcai.site/contact/>

stayed with me, particularly the ideas of human freedom and that we should take responsibility for our actions. My take on existentialism was in tune with the authors I was reading. Both Maugham and de Maupassant were naturalistic writers and were rather cynical with regard to human nature, showing up selfishness and hypocrisy when individuals' espoused beliefs did not match their actions<sup>4</sup>.

During these years I was also spending spare time on painting and craft. Under parental influence I was taking the academic stream at high school because I did well in maths, which meant not being able to take art. I was told that it was better to keep art as a hobby and focus on subjects that would make me more employable. Hindsight indicates the parents were right!

At the end of high school, a major decision point was reached. At this point, under the influence of the authors I had been reading, all I wanted to do was to begin living life and travel. My results in my final high school year, however, were such that I was awarded a Commonwealth Scholarship, which meant I could go to university without paying fees and receive a small living allowance. Again, under parental influence it was decided I should not waste this opportunity and so I enrolled at the University of Queensland. I was in such a state of confusion that I changed my enrolment several times in the first few weeks, eventually settling on a Bachelor of Science with majors in mathematics and psychology. Engineering and Arts had been the other choices. At that point there were no courses on computing in Queensland. Those years at university don't deserve much mention here, but they were fun. This was a time when there was no continuous assessment and just the one final exam for each course at the end of the year.

### 3 Industry Years

After three years at university another decision point was reached. Due to the lack of degrees in computing in Australia, the Australian government was employing people from a range of disciplines in the "programmer-in-training" (PIT) scheme, which combined on-the-job employment with studying special purpose graduate diplomas at partner institutions. So, in 1971 it was off to Melbourne to work for a government department and study for some months at a time at what was the Bendigo Institute of Technology. The subjects studied included COBOL, FORTRAN, PLAN (an assembler language), systems analysis and design and computer hardware. Rick Watson, later a professor at the University of Georgia was in the PIT intake the year before me in Melbourne along with his wife, but in a different government department.

My intake of 17 young people included 9 men and 8 women. None of us went near the mainframe computers, which were large and housed in special air-conditioned rooms. The near equal number of men and women, highly unusual today, was possibly because no one had yet worked out that computing should be more a male occupation. Legislation in Australia in 1969 had raised the female wage to 85% of the male wage. Equal pay for work of equal value was introduced in 1972. It was a time of change from which I benefitted. It had not been until 1966 that women in the Australian public service and some other organizations won the right to remain employed after marriage.

During the years that followed I was employed as a programmer, analyst/programmer and project leader. Back in Brisbane, I worked for the Brisbane City Council on systems for electricity billing, regulated parking and dog registration. Coding was done on coding sheets and was then transferred to punched cards and compiled on a mainframe computer. It was a point of pride to try to get a clean compilation with five compiles or fewer to avoid the risk of scorn by the operators in the mainframe room. I was also in charge of a new Singer System 10 small-business computer that was used for processing electricity account payments from early point-of-sale devices.

A significant innovation in programming occurred around this time. Programs in COBOL could be very long and could have GO TO statements on page one that branched to a line on the last page, leading to complexity that made programming and maintenance difficult. Edgar Dijkstra wrote his "Go To Statement Considered Harmful" article in 1968, leading to "structured programming"<sup>5</sup>. I encountered structured programming in a system produced for the Council by a consultancy company. Its merits could be seen just from observation and it was quickly absorbed into our practice. This case is one that shows clearly how theoretical work in academia can have impact in industry.

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<sup>4</sup> I have just re-read "Boule de Suif" by de Maupassant, which is a perfect illustration (Kirkbridge 1971).

<sup>5</sup> Structured or modular programming breaks down code into self-contained blocks (modules) that are controlled through the constructs of sequence, repetition, and selection – excluding branching from GO TO statements.

At one point while in Brisbane I enrolled in a Bachelor of Arts at the University of Queensland so I could study philosophy part-time. The courses did not match my expectations. The philosophy taught followed the British analytic tradition and there was no mention that I can recall of any continental philosophy. I recall writing essays on “What is Knowledge” and the “The Ontological Argument for the Existence of God”. I was still also studying art in evening classes when it could be managed.

At that time, it was almost a rite of passage for young Australians to save up and do an overseas trip before settling down to families. So, my husband and I went to the United Kingdom on a working holiday. In Glasgow I worked for a consultancy that provided systems that ran on NCR399 accounting machines. In 1977 I was in London managing a payroll system project for an engineering company and was hired by the Australian consulting company Datec Pty Ltd, as Australia was again suffering from a shortage of staff in IT. Datec paid the fares for myself and my husband to come back to Australia. We were able to negotiate a trip back overland by bus, a three month trip through Europe, Turkey, Syria, Jordan, Iraq, Iran, Afghanistan, Pakistan, Kashmir, India and Nepal. After a period with Datec in its Brisbane office I resigned and had a period as a stay-at-home mum. So, this was the finish of my work in the IT industry, something I had found extremely rewarding. I had very much enjoyed the problem-solving and creative aspects of software development, including the interactions with those for whom the systems were developed.

## 4 Move to Academia and Re-education

Becoming an academic was not something that I had ever envisaged. Speaking to largish groups of people, as in lectures, did not appeal to me and I had no experience with it. Also, amongst my industry colleagues, academics did not enjoy a good reputation – being thought a bit “out of touch”. When it came to finding part-time work, however, in a regional city in Central Queensland there was not much choice. I began tutoring at the local Capricornia Institute of Advanced Education and then when the lecturer in charge, Dr Jim Clark, left I began as a lecturer. Once started on this path it was obvious that if I kept going, I needed to do some more study, so I did some courses in computer science and then a Master's Degree in Applied Science by thesis.

For a time, it was not really clear where I belonged in disciplinary terms. I was working in a Business faculty, had a science background and had worked in industry at what was thought of as “computing”. I went to some Artificial Intelligence conferences and presented the expert system work from my Master's thesis but did not really seem to fit in. Then I went to the Third Australasian Conference on Information Systems in 1992 at the University of Wollongong and could see that this was my academic home. Fellow attendees whom I still see include Deborah Bunker, Rodney Clarke and Guy Gable.

By then also I had started a PhD at the University of Queensland with Professor Ron Weber. A stroke of serendipity had occurred here. There were sweeping reforms to the university sector in Australia between 1989 and 1992 and the “binary” system that distinguished Colleges of Advanced Education from universities was abolished. As part of this change, older universities were encouraged to take on doctoral candidates from the newer universities. Ron Weber was exceedingly generous in taking me on as a PhD candidate and it is something for which I will always be grateful. A fairly intense period ensued. I had teenage children and had to first do a number of coursework units in Brisbane, over 600 km from my home. My family's support during this time was much appreciated. In 1996 I obtained my PhD, by then in my mid-forties.

The experience of doing the PhD with the IS group at the University of Queensland played a significant part in my subsequent work as an academic. Ron had undertaken his own PhD at the University of Minnesota with Professor Gordon Davis as his advisor, so he was part of an excellent tradition. The research culture in the IS group at University of Queensland was then, and remains, outstanding. Doctoral candidates were expected to undertake a solid program of coursework in research methods, statistics and cognate subject matter before beginning their thesis, something that was not all that common in Australian universities. Ron's links to the North American IS community facilitated a sabbatical I had following graduation with Professor Izak Benbasat at the University of British Columbia. This visit led to our joint publication on explanations from knowledge-based systems in *Management Information Systems Quarterly* in 1999.

Before and after my PhD I had been undertaking applied research with industry in areas such as electronic commerce in the beef industry and the use of knowledge-based systems in agriculture.

Rockhampton where I was living is known as the beef capital of Australia and the beef industry was able to fund projects.

The story up to here has followed events as they happened in my working life. It can be seen that it was a rather varied career and there was a good bit of happenstance. I suspect that my story may not be that much different from a number of people in IS – being a new field we have absorbed people with a wide variety of backgrounds, especially in the earlier days. This diversity in my background I think goes some way to explaining how things developed with my work on theory and design research.

## 5 Design Research and Theory

The work I have done on design research and the nature of theory in IS grew out of the puzzlement I felt when coming to the IS field after a background in maths, psychology, computer science, working in industry and reading in the philosophy of science. One would think that a field that deals with socio-technical systems and thus involves both humans and machines should be able to encompass a variety of research approaches. The aim of IS research was given early on as the “study of the effective **design**, delivery, use and impact of IT in organisations and society” (Keen 1987 p.3, emphasis added). Yet in IS we did not seem to understand what design-type research should look like and even whether it was legitimate. Design research, as in the building of artifacts such as algorithms, is the norm in computer science although there is comparatively little examination of relevant research methods<sup>6</sup> and the terms “design science” and “design research” are little used. This situation may be because of the close link between computer science and mathematics, where again methods on how to do something are a well-recognized form of knowledge, but there is not so much on how research is conducted.

My puzzlement found its first expression in a paper written by Frada Burstein and myself that appeared at the *Australasian Conference on Information Systems* in 1999. Frada and I referred to the “systems development or engineering approach” to research. Our aim was to develop criteria for the conduct and evaluation of this type of work. We drew on the relevant work that had appeared at that point, from authors including Jay Nunamaker, Juhani Iivari and Sal March<sup>7</sup>. We also linked this type of work to action research. When I presented this work at the conference, I was called a “positivist” by one member of the audience, because I had used the word “proposition”. More puzzlement!

In 2001 I moved to the Australian National University (ANU) in Canberra as a professor and the environment there was extremely conducive to intellectual activity. I became the Director of the newly formed *National Centre for Information Systems Research* and our group in 2002 began a biennial workshop series on “Information Systems Foundations”. Dennis Hart and I edited the proceedings until he retired. We had some tremendous speakers and work presented at the workshops, from people including David Arnott, Bob Colomb, Jacob Cybulski, Walter Fernandez, Peter Green, Juhani Iivari, Marta Indulska, Simon Milton, Robert Johnston, Helen Hasan, Jan Recker, Michael Rosemann, Iris Vessey and Phil Yetton. It was a small workshop with a single stream, so everyone got to hear and discuss everyone else’s work – very exciting happenings.

At ANU there were also fondly remembered meetings over lunch of what we termed the “P&W” club<sup>8</sup> in Fellows Gardens at University House, with colleagues including John Campbell, Dennis Hart, Ed Lewis and Craig MacDonald, where we took turns to discuss philosophical topics of interest,

Another act of generosity made a key difference to my thinking around this time. In 2001 I visited Brunel University and the late Professor Ray Paul, seeing the issues I was grappling with, gave me a copy of “Confessions of a Philosopher” by Bryan Magee. Magee wrote a very readable personal history of his own encounters and ideas about philosophy, beginning with his experiences at Oxford University with the analytic tradition and linguistic analysis and then moving on to an appreciation of, amongst others, Popper, Kant, and Schopenhauer. As I had had only a brief period of studying philosophy formally, this work gave me a guide to important work that I had paid insufficient attention to, Immanuel Kant in particular. I recommend it to others.

My paper that appeared in 2006 in *MISQ* as “The Nature of Theory in Information Systems” stemmed from my continuing puzzlement with different research perspectives in IS and the lack of recognition of design

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<sup>6</sup> An exception is the work by Justin Zobel (2005).

<sup>7</sup> Ron Weber had sent me the 1995 March and Smith paper on design and natural science research, which may have been a catalyst for this work.

<sup>8</sup> “P&W” referred to “Popper’s World” or “Philosophy and Words”, or something else.



knowledge. I had a group of doctoral candidates who had arguments over whether they were positivists or interpretivists and it seemed that there was not a good understanding of what these terms meant and they were not well founded in what I read in philosophy. My thought was that some of the differences in opinion were to do with the different disciplinary backgrounds that people had and that perhaps views could be harmonized, or at least seen in some form of relationship to each other, if we looked at the different purposes that different forms of knowledge served. So, I distinguished between theory for: (1) analysing; (2) explaining; (3) prediction; (4) explaining and predicting; and (5) design and action. The work was presented at various conferences and seminars and benefitted enormously from critiques. I was also fortunate at having Allen Lee as Senior Editor and Lynn Markus and Michael Myers as reviewers, as they were extremely supportive, even if the work did not entirely match their own thinking. In hindsight, when I re-read the paper, it seems to me to a bit “preachy”, but that may be because I was trying very carefully to explain what I thought myself at the time. I have had a number of people, particularly doctoral students, tell me that the essay helped them in making sense of the IS research landscape. My own views of theory and theorizing have evolved in some ways since then, as can be seen in subsequent work (e.g. Gregor 2017), although the main message remains the same. There is one thing that I think is missed by some readers in referring to this work. I stated that the word “theory” was used “rather broadly to encompass what might be termed elsewhere conjectures, models, frameworks, or body of knowledge” (Gregor 2006 p. 614). I was not thinking of “theory with a capital T” – meaning Type 4 theory - which is what I think some authors are referring to in debates about a “theory fetish” in IS. In fact, the point of the essay is to show that there are different forms of knowledge (theory) - all valuable.

Continuing with the mission of making design research respectable, “The Anatomy of a Design Theory” appeared in 2007, co-authored with David Jones. David was a doctoral candidate who had had the good fortune to have studied philosophy as well as IT in his undergraduate degree and then worked in IT. For his thesis he had developed an e-learning platform and expressed the knowledge developed as a design theory. He presented his work at the first DESRIST conference in California in 2006. Again, with later thought, I personally would put less emphasis on the possibility of developing a whole theory from a single development project, as I now think a well-developed theory or body of knowledge would build up over a period of time and number of cases, so the scope of the theory is better understood and the evidence for it better established. Later work with Leona Chandra Kruse and Stefan Seidel looks at how design principles are formulated, as they are a key component of design theories.

The third paper in the design and theory stream that has received most attention is the 2013 *MISQ* work with Al Hevner on “Positioning and Presenting Design Science Research for Maximum Impact”. Al is recognized as one of the leaders in the design science movement in IS and it has been a pleasure to work with him. The idea for this paper grew out of casual conversation with Al at the DESRIST conference in St Gallens, Switzerland. One contribution of the paper was a matrix that showed the different categories of contribution that could be made in design science: invention, exaptation, and improvement and also routine design. Colleagues tell me that they are able to use the 2x2 matrix with partners to define industry-led and industry-based research. Another part of the paper that colleagues appear to find useful is the depiction of levels of design science contributions from: 1) artifact implementation to 2) nascent theory (principles, architectures) to 3) well-developed design theory. Again, with this publication we were fortunate to have as a Senior Editor someone who was prepared to take a risk on something that was a bit unconventional, namely Detmar Straub.

I will mention one more project as it illustrates a different aspect of my work, namely the conduct of design research rather than discussion of it. In this case it was an action design research project undertaken in Bangladesh with Ahmed Imran and Tim Turner and funded by AusAID. The aim of the project was to address the problem of limited adoption of e-Government in Bangladesh, where it was seen that e-Government could have positive economic and societal outcomes. The project ran for over five years and involved us travelling to Bangladesh several times and staying in the public sector training academy. It was a great experience, even if a bit exciting at times, as when there was a “hartal”, a political demonstration. There was only one journal article (Gregor et al 2014) on the action design research aspect of the project and that was a difficult process, taking five revisions. One reviewer had very fixed ideas about us adhering to the exact depiction of action design research in Sein et al (2011).

How is design research faring in IS after discussion of it began about 30 years ago, albeit under different labels? My own feeling is that much progress has been made. Design science research is now a well-



recognized paradigm, even if there is still debate about some aspects<sup>9</sup>. There are exemplars in our top journals and studies of publication patterns show a reasonable number of articles at up to 25% in some of our leading journals<sup>10</sup>. Alexander Maedche, Jeff Parsons and I<sup>11</sup> analysed patterns of publications in one stream of work, namely explanations and intelligent systems, and found that the majority of a sample of publications was either primary studies of construction or manipulation work, where researchers experimented with features of an artifact. There were no secondary studies of artifacts as deployed or theory and review type articles. The review by Nagle et al (2022) had similar findings. This lack of external scrutiny and independent evaluation is something that could be addressed, as is the paucity of theory and review articles. My own attempts with colleagues at the latter have not met with success.

## 6 Concluding Remarks

In these reflections I have not dealt with my publications outside design science or with the service roles I have performed, or various awards. One achievement that I will mention is the honour of being made an Officer of the Order of Australia in the Queen's Birthday Honours list in 2005 for services to agribusiness and education. My mother was able to attend the ceremony at Government House in Canberra and remarked that "it has made it all worthwhile". I am not quite sure what she meant, but it may be that something like the capacity for independent thinking and strong-mindedness that can be valuable to an adult in her career are not so much appreciated by parents trying to bring up a child.

I have been fortunate in being able to undertake a range of types of work, particularly experimental work, which has meant that there was a bit of leeway in taking on what could be seen as more risky work in design research and conceptual articles. The account above shows other ways in which I have been fortunate, particularly with individual acts of generosity at key points and also the open-mindedness of some editors and reviewers and the willingness of colleagues to constructively criticize work-in-progress. I hope these attitudes are something I have been able to pass on. My PhD students have been another wonderful group of people and I am happy that so many of them stay in touch. In a short account I have not been able to mention all the people who have made a difference to my working life, but I do thank them.

Today as a Professor Emerita I continue to do some academic research on topics of interest. I have also been able to revive my interest in art and spend much of my time painting. There is some cross-over in that there are well-recognized design principles in art and marrying them with continuing practice and my perhaps limited artistic creativity is an absorbing occupation.

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<sup>9</sup> See Gregor (2021).

<sup>10</sup> e.g. see Engel et al (2019), Nagle et al (2022)

<sup>11</sup> Maedche et al (2021)

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## About the Authors

**First Name Last Name.** After the references and the appendices, if there are any, come short biographical sketches of each author. The bios should be in normal text format, with a separate bio for each author. Put the author's name in bold at the start of the bio. Do not include titles such as "Dr." or "Professor". Italicize all journal titles in the biography. If referencing the *Communications of the Association for Information Systems*, spell out the entire name of the journal, just as in this sentence, rather than using the acronym for AIS. The maximum length of each biography should be approximately 150 words. Do not include email addresses.

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