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Alan F. Blackwell:
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From keynote address, 2008 DRS conference: "Undisciplined"

Alan F. Blackwell

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Can a person be a designer and also be disciplined? More properly, can one be a design researcher, and also a member of an academic discipline? This paper is based on an invited address to the Design Research Society, given under the title "On Being Undisciplined". I have set out to analyse some of the fundamental tensions between the social and epistemological dynamics of contemporary academic life on one hand, and the lived experience of professionally engaged design work on the other. This has been done with a degree of rigour, including large-scale reflective design research projects, undertaken with diverse teams of disciplinary experts who are well qualified to study and understand such broad questions. However it starts with some more idiosyncratic personal and historical reflections, a privilege that is generally allowed to keynote speakers, but not so often translated into print.

Alan Blackwell

Alan Blackwell (UK) is Reader in Interdisciplinary Design at the Cambridge University Computer Laboratory, with qualifications in professional engineering, computing and experimental psychology.

He had 12 years experience of designing industrial systems, electronic and software products before resuming academic research in 1995. He has taught design courses and supervised postgraduate design research students in Computing, Architecture, Psychology, Languages, Music and Engineering. He is a fellow of Darwin College Cambridge, founding director of the Crucible Network for research in Interdisciplinary Design since 2000, and a director of the public cultural consortium Living East. His research involves the development of technologies for home automation, visual representations and end-user programming, based on empirical and critical research into the human and social contexts of technology.

Being 'Undisciplined' Today

My research draws on 20 years of personal experience in and around the city of Cambridge, both as an academic and as a design professional. It also draws on 20 years of earlier education and design experience from far away. New Zealand is as far as one can go from Cambridge, and still be in a university. The University of Cambridge is 800 years old, and my present department taught the first Computer Science graduate programme in the world since 1949. New Zealand is one of the youngest countries in the world. In 1989 I was only the third person to graduate with a Computer Science master's in Wellington. However the drama in this story is not the contrast between my lives in these geographically and historically remote countries, but between my lives in two professions: as a designer and as an academic.

My professional life has encompassed a full range of design, from heavy industrial automation to software and home appliances. My academic life has led me to take degrees in engineering, comparative religion, computer science and psychology. It is perhaps not surprising for a person who moves between countries also to undertake intellectual exploration – the life of the permanent immigrant prevents assimilation within any one culture, and encourages critical reflection on one's environment. Although hesitant to offer personal views as generic, the diversity of my experience appears sufficiently unusual that my struggles with disciplinary boundaries may be of more general interest. Indeed, despite the many differences on each side of the divide, I now believe that it is the world views of professional design and of academic discipline that are most fundamentally opposed, rather than any individual disciplinary distinction.

The extraordinary gulf between these world views can be seen on the most local of scales. Rather than a 24-hour plane flight passing billions of people when travelling to my family in New Zealand, the whole story of the tension between design and the academy can be experienced in the distance that I ride my bicycle every day, in a city of fewer than 100,000 people. Cambridge is built on a very compact scale – I can ride from farmland on one side of the city to the other in 20 minutes. I pass through the medieval centre, with narrow streets, ancient chapels and many small student rooms. The surrounding suburbs are largely Victorian-era high-density terrace housing, then a further ring of low-cost 20th century development before the science parks and campuses on the outskirts of town. It is the last that drew me to Cambridge, and finances the luxury of this reflection. Despite its tiny size and ancient history, Cambridge has become the most prominent high-technology research and investment centre in Europe. However before investigating more closely the huge tensions that arise from the juxtaposition of medieval university and high technology, I wish to consider a particular turning point, in the life of one prominent Victorian.

Being 'Undisciplined' in History

Horace Darwin was the youngest son of the famous naturalist Charles. Several of Charles Darwin's sons settled in Cambridge, where the family wealth allowed some comfort,

to an extent that three of their houses later became Cambridge Colleges. My own college, now called Darwin to honour the family, was founded in the house built by George Darwin, who was professor of astronomy. Horace, however, was not an academic. He was rather a 'black sheep', choosing to go into trade rather than academia. After completing his mathematics degree, he spent some time as a consultant to engineering companies, which was not considered respectable in the 1870s. His future in-laws regretted that he had "no proper profession or likelihood of earning a decent living" (Cattermole & Wolfe 1987). In 1881 he founded a company that the family disparagingly referred to as 'Horace's Shop', but was formally registered as the Cambridge Scientific Instrument company.

Cambridge did not have a good record for supporting the practical side of scientific research, perhaps from the tradition that a gentleman scientist could afford to purchase his own apparatus as necessary. The first Professor of Mechanism (James Stuart, appointed 1878) was not provided with a laboratory or any technical staff, so was forced to buy a wooden shed to house his practical classes. These classes were taught by demonstrators whose wages were supplemented by building pieces of apparatus for the physiology department. It was this shed that Horace Darwin turned into CSI, moving the business to premises just across the road from my own Victorian house, where he pioneered a great variety of scientific instruments, including seismographs, cloud chambers, and many others. I often think of Horace, as my cycle route to work crosses the route that he took every day on his tricycle. He became a successful 'tradesman', as he put it, was Mayor of Cambridge for a time, and was knighted for his services to engineering as a member of the WWI Aeronautics Commission. However his relationship with Cambridge University was never so respectful.

Around the time of Stuart's appointment, Horace Darwin was writing to his brother "I should very much like to do anything I could to make an engineering school up there". Darwin never did hold an academic post, but when Stuart resigned in 1887 after sustained opposition to the creation of an engineering degree, Darwin ran a poster campaign in the town, criticising the conservative academic opposition to engineering. Eventually he was successful in overcoming that opposition, leading to proper funding for engineering at last, and was invited to serve on the committee that appointed Stuart's successor.

There is now a large engineering department in Cambridge (in fact the largest department in the university), and for many years it followed Darwin's observations regarding the attributes of an engineer: he observed that an engineer has "much to do with governing men" (the Judge Business School and the Institute for Manufacturing emerged from Engineering and still reside within the School of Technology), requires "a fair knowledge of mathematics and physics" (although Cambridge has a specific engineering focus, now that both pure and applied maths departments have moved a couple of miles away to a special campus isolated from engineering) and "you must work with your hands" (Cattermole & Wolfe 1987). The department still treats engineering as a practical design discipline, with a large Engineering Design Centre, design courses and research in the Institute for Manufacturing, and innovative programmes such as the masters in Interdisciplinary Design for the Built Environment. However the practical design orientation still brings tensions, and it is increasingly uncommon for either students or professors to 'work with their hands'. Their main opportunity to do this comes after they leave the University, as I explain.

The 'Cambridge Phenomenon'

Cambridge is distinctive not only for the age of the University, but for the scale of economic development that has resulted from high technology business. Cambridge housed the first 'science park' property development in the UK, and saw first hundreds, then thousands of start-up companies in science parks, business incubators, and small offices around the city. It is widely believed that this economic wealth originated from the research of the university, but this is not the case.

A now famous report on 'The Cambridge Phenomenon' (Segal Quince & Wicksteed 1985) included a family tree tracing the lines of descent as staff moved from company to company, founding new enterprises. The root of this tree was Cambridge Scientific Instruments. The first spin-off was created by Horace Darwin's shop foreman William Pye, who left CSI with his son to establish the company that later became Pye Radio, and then a major division of Philips. The next was Cambridge Consultants Limited, founded by recent graduates who went on to "... recruit a variety of highly talented individuals some of whom perhaps too easily tended to do things that interested them without regard to commercial realities." (Segal Quince Wicksteed 1985). It was CCL that first employed me in Cambridge, as a member of an Artificial Intelligence group attempting to create products based on AI technology.

The first dramatic commercial success in Cambridge was Acorn computer, one of whose founders was a Cambridge technology graduate (now my head of department), but which otherwise originated from adventurous business people, one from Pye, as well as the kind of technologists best described as mavericks, including early contributions by Sir Clive Sinclair, a famously non-academic British technologist. Cambridge has developed a great deal of infrastructure to support entrepreneurs (patent lawyers, short-lease incubator offices, venture capital companies), and these certainly make it easy to start businesses in Cambridge, but how many of these can be attributed to the presence of the University?

Knowledge transfer and commercial success

Current UK research policy places great emphasis on 'knowledge transfer' – evidence that public investment in academic research ultimately results in economic benefit from the sale of products resulting from that research. Cambridge would appear to be the most dramatic evidence of this economic opportunity, but there are reasons to question the currently accepted model – reasons closely related to disciplines and design.

There are indeed several large and economically successful companies in Cambridge, but these have generally been spun out from other existing companies, rather than having direct origins in academic research. ARM supplies most microprocessors for mobile and portable devices, but it was spun out from Acorn. Cambridge Silicon Radio (CSR) supplies much of the world's Bluetooth communications technology, but was spun out from CCL. When I was at CCL, few staff were even Cambridge graduates. My experience of 'Silicon Fen' is consistent with the experience of Silicon Valley. As in Cambridge, most Silicon Valley companies are not spin-outs from Stanford University (although some are) but spin-outs from other Silicon Valley companies (Owen 2004).

Furthermore, it is often noted that those Cambridge companies most clearly linked to the university tend not to be successful with the kind of products that apply new research advances to an actual user market. Instead, they are successful at creating the kind of tools that are sold to other technical specialists, for use in making products elsewhere (Rosenberg 2002). This suggests an absence of user-oriented design thinking. Instead the process of knowledge transfer is often presented as if it were a pipeline, with scientific research results entering at one end, being converted into patents and licence agreements, and emerging from the other

as products and commercial enterprises. This is almost the reverse of any reasonable design process, in which it is the requirement or market opportunity that forms the starting point for design.

Cambridge has also hosted many corporate research laboratories, for product manufacturing companies including Microsoft, Nokia, Xerox, Kodak, Intel, Toshiba and so on. These labs do have close contact with the University, often employing university graduates and directed by university professors. However these labs also struggle to contribute to the products of their companies. The corporate labs of technology companies are structured and staffed according to academic disciplines and scientific endeavours, not according to market opportunities.

The mountaintop and the swamp

These observations can be related to the parable presented by Donald Schön (1983), in which design problems, in order to become scientific questions, must shake off those aspects of the problem that do not contribute to the central theoretical issue. That issue becomes a focus of attention, with the design researcher climbing out of the mass of irrelevant details, toward a far mountaintop on which the pure essence has been captured, to be described in equations and uncontestable theories. From this mountain, the researcher finally has an answer that can be applied to the original problem. He looks down to the swamp he came from, where the mess of everyday design activity is in progress, where every issue is entangled with every other, and people are throwing mud at each other. He calls down that he has found an answer on the mountaintop, but the people in the swamp are not greatly impressed or even interested. Furthermore, now that he is a professor on his own mountain, he is strangely reluctant to return to the swamp himself.

This simple parable describes most of the encounters that I have experienced between design work and academic work. It explains why Cambridge companies are relatively seldom founded by Cambridge academics. It explains why Horace Darwin was the black sheep of one of the most prominent academic families in Britain, despite providing the point of origin for the Cambridge Phenomenon. It explains why Cambridge university spin-offs sell their results to other technologists (who appreciate the qualities of the mountaintop) rather than designing products for end-users. And it explains why corporate research labs happily engage in sci-

entific pursuits that they have agreed on with their friends in the university, while finding it difficult to influence their company's new products.

It is fundamental to academic disciplines that they must address well-formulated problems, that they must agree on what kind of a problem they are addressing (i.e. which discipline it belongs to), that there are agreed methods for addressing the problem, and agreed criteria for what constitutes an answer. All of these attributes are at the centre of academic rigour, and of the intellectual 'discipline' that constitutes an academic discipline. Yet these qualities of rigour and discipline are mostly in direct opposition to the practices and values of design.

Furthermore, the research policy fiction of 'knowledge transfer' – that economic benefit can result from pursuing the best standards of academic research – has no evidence to support it. Those academic fields that are most engaged in responding to outside problems, including architecture, education, product design, are those that struggle most with the regimes of academic quality assessment. The only exceptions are those where the historical development of the profession has been able to mould society's expectation of what professionals will achieve, into a form that is compatible with academic conceptions of knowledge. And even these tend not to rely solely on academic knowledge, but to supplement it with further professional training (admission to the bar, medical registration or priestly ordination), all of which are able to counter academic discipline through encounters with real professional problems.

Commensurability, metrication and interdisciplinarity

Despite the evident truths encapsulated in Schön's parable, the policy conception of the academy as a source of exploitable knowledge is likely to remain in place. Design research fields, if they stay faithful to their true mission, are ever likely to become engaged in problems that defy conventional concepts of academic rigour. Yet academic disciplines cannot remain islands, completely isolated from each other. Product designers and start-up companies must draw on specific kinds of technical expertise (even though these 'applied' engagements are likely to harm the careers of those collaborating, who might otherwise have sought the higher status and rigour of 'pure' science). Students must choose between fields of study. Research funding bodies and universities must allocate resources across university departments in a systematic way.

All of these processes demand that disciplines be made 'commensurable' – that they can be compared and measured against each other (Strathern 2004). The research policy response is to define research 'metrics' – numbers that allow the direct comparison of one piece of research to another. Except that very few researchers, even those in pure disciplines, believe that the value of their research can be encapsulated in a number. The reason why the boundaries of knowledge must be traversed numerically is that, in contemporary consumer society, all public policy must be expressed in dollars or pounds. Academic knowledge must have a number attached to it, in order to write an equation by which society will purchase that knowledge for transfer to students and products.

But this appears to be a nonsense, if we take Schön's parable seriously. The knowledge that achieves greatest academic consensus for its disciplinary rigour and authority will be the knowledge that is least entangled with real design problems. Research metrication and knowledge transfer are equally dysfunctional policy conceptions of the role of the academy. Many academics, even those in traditional disciplines, also suspect and are uneasy about these policy trends. In response, the UK government has commissioned reassurance from consultants who wish to demonstrate that there is no problem.

Ideally, the 'best' research (from a public policy view) should have benefits beyond its originating discipline, being applied to other problems, or combining multiple forms of knowledge through interdisciplinary research. But those who undertake interdisciplinary research complain that such research is disadvantaged by research metrics, because it is not recognisable to, or commensurable with, the standards of rigour within the 'core' disciplines. A consultancy report commissioned by a UK academic funding body (Adams, Jackson & Marshall 2007) investigated this question, and concluded that there was no problem – that numerical analysis of a large scientific citations database showed no disadvantage for interdisciplinary research compared to that within single disciplines.

This conclusion is widely believed, and will form the basis for future policy, yet the study by Adams et. al. was deeply flawed. It considered only research in science, technology and engineering, because these were the only areas included in the citations database used. Those disciplines where real people and problems are not mediated by professional

accreditation – design, humanities, arts, social science – were not included, and neither was any interdisciplinary endeavour between science and those disciplines. The categories of 'interdisciplinary' exchange considered in the study included citations across journals of statistics as one discipline and journals of engineering statistics as another.

A strategy for interdisciplinary design

My own work in the University of Cambridge has pursued a particular strategy by which the problems described above might be addressed. As a professional designer with diverse academic interests, I was open to any technique by which academic work and knowledge might be made valuable to the world outside the university. One strategy for doing this is the basis on which CCL, and the many other technology consulting companies in the Cambridge area that have spun off from CCL, manage the process of creating expert teams to address the design problems of a client. These companies usually apply a matrix management structure, in which the internal organisation groups people according to shared disciplinary knowledge, but clients experience the company in a way that cuts across these disciplines, most importantly in the construction of project teams that draw staff from multiple parts of the company in response to client needs.

After completing my Cambridge PhD in Psychology (at the Applied Psychology Unit – closed soon afterward in order to focus on more rigorous and less applied work in neuroscience), and then finding a design teaching post in Computer Science, my next action was to create a matrix organisation that could convene interdisciplinary project teams in the manner of CCL. With David Good, a colleague in the faculty of Social and Political Science, we created the Crucible network for research in interdisciplinary design in 2001 (Blackwell & Good 2008). Through the simple precaution of never seeking direct funding, never claiming the status of a department, never competing for office space or staff resources, and ensuring that project benefits went to the individual people and disciplines involved, we have managed to avoid direct opposition, despite the fact that our work seldom meets the standards of pure disciplinary rigour. Having been recently appointed to a Readership in Interdisciplinary Design, my own chronic lack of discipline has not yet been severely punished.

Nevertheless, the Crucible network does not have an easy life or receive wide recognition in the University of Cambridge. Certainly not in proportion to the scale of its activity, much of which is invisible to conventional disciplinary accounting structures. Our 100 or so members come from many disciplines and institutions, so that the 50-60 funded projects, thousands of collaborators and participants, and millions of pounds of research funding have never appeared in any single account or set of research metrics. Administration of resources in Cambridge is carried out strictly according to the departments that admit students, train them in disciplinary specialities, define and convene publication venues, and promote the appropriate standards of rigour for each discipline. Those fields that remain committed to external problems rather than intellectual positions (architecture, education) are often the least respected departments in a university like Cambridge. Indeed the architecture faculty was recently threatened with closure after poor performance in a round of metricated research assessment. This does not augur well either for design or for interdisciplinarity.

The value of reflection

As a result of its firm base in the social sciences, Crucible has one distinctive benefit that is particularly appropriate to its design work. This is the constant habit of the social scientist to reflect on the social status of his or her own work, whether engagement with those people and cultures being described, or the structures and dynamics of the scientific discipline itself. All Crucible projects include explicitly reflective components, often involving social science observers who are incorporated into a project team purely with that role. This can be surprising to research funding bodies, and even unwelcome, where the reflective observers question the motives or working methods of the funding body. Nevertheless, it has been a remarkable resource for innovation. In the style of Schön's reflective practitioner (1984) we conduct our interdisciplinary work as a design enterprise, and treat our research work as a design practice.

Recently, we have found opportunities to work with others in reflecting on their practice. In the Across Design project, we compared the practice of many different design professions, from a phenomenological perspective of reflection on personal experience (Blackwell et al in press). We are now completing a project investigating the relationship between interdisciplinarity and innovation, once again through reflection on the personal experience of those who are considered to be national leaders in this practice. We hope that the outcomes of these projects might influence UK public

policy, and also the organisation of research enterprises within universities, corporate research laboratories, and design research practices.

The nature of the findings from these projects has tended to focus on the significance of the social context in which interdisciplinary design research work is carried out, and the ways of working that are effective in those contexts. On occasion, specific work processes are required as a result of material constraints or tool limitations within a particular design tradition, but on the whole, we have found ample evidence for the value of 'design thinking' as being a significant contribution across many design disciplines.

In the case of interdisciplinary innovation as an analog of traditional design, we find a particular combination of organisational resource, personal style, and organisational structure. The leaders and founders of inter-disciplines resist convention and develop a strong personal vision while also being mentors and coaches to their colleagues. For all involved in this kind of work, innovation arises from freedom for serendipity rather than targets and constraints, but the main personal 'discipline' that must be nurtured and rewarded is that of maintaining curiosity. This is both a personal and organisational challenge, because of the long timescales involved for the most valuable research. New ways of thinking and working require years to develop, rather than months.

The Discipline of Crucible

The Crucible network has responded to this challenge by attempting to start small and move fast at the outset of projects, in order to facilitate encounters between communities. Rather than develop complex mechanisms of formal collaboration, we do our best to treat "Industry" as another discipline, rather than a munificent, threatening or exotic other as often happens in academic policy discourse. We aim to bring a wide range of creative and design practices to technology research, often in place of, or alongside, conventionally rigorous scientific perspectives. In reflecting on these ways of working we hope not only to influence and renew our own practices, and those we work with, but also to ensure that places are created within public policy to allow both design and innovation to continue within research environments.

Alan Blackwell

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