HCI as an Inter-Discipline

Alan F. Blackwell
University of Cambridge
Computer Laboratory
Cambridge CB4 3EL, UK
afb21@cam.ac.uk

Abstract
This paper responds to a 2014 paper by Liu et al seeking a quantifiable thematic core to CHI. As an alternative, I argue that CHI should strategically avoid the search for such a core, instead seeking its identity as a mode of responding and contributing to other disciplines.

Author Keywords
Interdisciplinarity, innovation, collaboration

ACM Classification Keywords
H.5.0 HCI – General; K.4.1 Computers and Society - Public Policy Issues

What is the Problem?
In 2014, Liu et al [13] published a comprehensive bibliometric analysis of keywords used in CHI publications over the last 20 years. They identified major themes, and more importantly, network dynamics by which themes are related, becoming more central or peripheral over time. They confirmed that, as many of us suspected, there have been large shifts in which topics are popular. Whole new conferences have spun off in response to specific technology trends, and the overall churn is so large that the authors felt the changes across the two decades of their study must be described as a paradigm shift.

But a more worrying implication of their work was their concern that HCI might not be achieving the bibliometric characteristics that make a discipline sustainable - they observed that the emergent thematic clusters are under-developed and 'transversal', rather than providing a 'motor' for continued scientific growth. They conclude that the only tradition in HCI is of having no tradition, that we behave "like nomads chasing water and grasslands", not accumulating knowledge, but rather assembling a 'pot-pourri' - a situation that they suggest we must accept, for better or worse.

This analysis is discouraging, if one believes that the primary goal of CHI is to establish and sustain a scientific discipline. However, Liu et al do not explicitly state that goal. On the contrary, they start by observing that CHI is a *venue* characterized by 'strong multidisciplinarity' rather than a *discipline* in itself. Their subsequent analysis of publications at CHI takes care to refer to the people attending the conference as a 'community', and their shared inquiry as a 'field' rather than a discipline.

Indeed, CHI might be regarded not even as a scientific field, but as a professional association, oriented toward practitioners as much as researchers (see the first sentences of the SIGCHI aims and CHI 2015 welcome), in which case 'community' is indeed a more appropriate way to refer to the aggregate body of CHI discourse, whatever its scientific status.

Scott Kim's Solution

This suggestion that HCI might be, not so much a discipline, as a way of talking between applied practitioners, had already been rather eloquently stated before the start of the 20-year period studied by Liu et al. In his contribution to the classic collection *The Art of Human-Computer Interface Design*, Scott Kim offered advice on the value, conduct and need for interdisciplinary cooperation in HCI [11]. The 1990 book to which he contributed was a state-of-the-art survey of the methods and theories underlying the design and effective application of the GUI, published at the point in time where the Apple Macintosh had fully established that user interfaces would become a key commercial asset.

Many chapters in *The Art of Human-Computer Interface Design* reflected on the need for interdisciplinary collaboration, but writing for an audience of practitioners rather than scientists. The key challenge was how graphic artists and designers could work effectively alongside programmers. At that time, projects such as Knuth's Metafont had started to indicate how far the boundaries between these established professions might be disrupted by the need to integrate design skills with computing.

The themes of Kim's chapter are: that different disciplines have different priorities; that despite threats to those priorities it is necessary to "stick your nose into other people's business"; that this requires drawing on the narrative, creative and persuasive skills of the ambassador; and that it is possible to modify organizations in a way that will support and maintain such activities. He concludes that the effective pursuit of these practices results in the creation of 'interdisciplinary disciplines'. Kim concludes that 'discipline' is the wrong way to think about the value inherent in a field like HCI. Rather than a speciality, he suggests that an interdisciplinary field might be called a 'generality.'

Scott Kim's advice from 1990 suggests an alternative interpretation of the bibliometric findings reported by Liu et al in 2014. While one alternative for our future is the pursuit of discipline (thematic cores, cross-citation, scientific sustainability), the other is pursuit of something *between* disciplines - an *inter-discipline*. My purpose in the remainder of this paper is to set out what HCI might look like as an inter-discipline.

Related Work

The analysis of HCI as fundamentally interdisciplinary, rather than disciplinary, suggests that the core theoretical understanding of HCI should incorporate classical accounts from the sociology of knowledge, and from science and technology studies, of the ways in which knowledge is constituted in interdisciplinary encounters.

For example, in the analysis of Peter Galison [8], we can observe ways in which the CHI community operates as a *trading zone* where engineers and technology designers are able to achieve productive exchanges with researchers offering insight into user experiences and behaviour. As argued by Fincher and Petre [7], all academic computer science can be seen as relying on the development of trading zones between the mathematical and technical concerns of the discipline, and the ways in which this knowledge must be mobilised in education and application of professional practice. In this analysis, HCI is not solely an 'interface' field necessary where computer science must engage with the outside world, but an essential independent model that can be drawn on to maintain the discipline of computer science itself.

Pragmatic advice for the day-to-day operation of HCI initiatives can be taken from Star and Griesemer's conceptualisation of the *boundary object* as a fluid construct able to accommodate different conceptual interpretations within different knowledge systems [17]. Although boundary objects need not be designs (and Star and Griesemer's original context of study was natural history rather than technology), creative design processes rely on strategies that avoid early fixation. Treating the artefacts of design (sketches, prototypes, scenarios) as boundary objects for disciplinary encounters is an opportunity to integrate the vigour of intellectual inquiry into pragmatic professional work.

Organisational sociologists have drawn attention to the ways in which organisational structures rely both on bounded communities that act somewhat like 'disciplinary' centres within large organisations, but also rely on mavericks and brokers to achieve effective work across those boundaries [4]. This analysis will resonate with experiences of many interaction design practitioners, who find themselves as negotiators, or even disrupters, in the relationship between engineers and users.

This activity can be compared to Stokes' characterisation of work in *Pasteur's Quadrant* [18] where use-inspired basic research is able to draw both on considerations of use and on a quest for fundamental understanding. More broadly, Gibbons et al. draw a distinction between *Mode 1* and *Mode 2* knowledge production [9]. In Mode 1, knowledge is conventionally produced within disciplinary academic boundaries, but Gibbons et al. claim that this mode is being superseded by Mode 2 knowledge production, carried out in 'the context of application,' and involving communication between researchers and stakeholders having heterogeneous knowledge and skills. These actors come together in networks rather than institutions. However, the localization of knowledge production in a context of application requires reflection

Crucible: A portfolio of collaborations between technologists and:

Art and design: e.g. Fine art, Architecture, Dance, Sculpture, Music

Medicine: e.g. Psychiatry, Pharmacology, Gerontology, Intensive care

Biological sciences: e.g. Ecology, Paleontology, Zoology, Genomics

Human sciences: e.g. Anthropology, Geography, Psychology, Sociology, Economics, STS

Professions: e.g. Social work, Education, Law, Business, Urban planning

Humanities: e.g. English, Divinity, Linguistics, Italian, Semiotics, Philosophy

Physical and mathematical sciences: e.g. Acoustics, Statistics

on the impact on users – reflexive social accountability is thus part of the production of knowledge.

The reflection inherent in these attitudes toward HCI as an intellectually-engaged professional endeavour is of course characteristic of the professional style described by Donald Schön as the Reflective Practitioner [16]. However, the contexts in which Schön's work has now been adopted often continue to conceptualise their work within a framework of stable professional structures, and it is unclear whether this is the status that HCI should aspire to.

All of these are valuable as accounts of how interdisciplinarity works as the key dynamic in HCI identified by Kim, but the question raised by Liu et al is how HCI itself could be consolidated through a process of eventual stabilisation. If this is to occur, then lessons from the comparative history of science [14] suggest that disciplines are not determined by objectively differentiated bodies of scientific knowledge, but emerge in communities having a common interest in a professional context.

Testing Disciplinary Stabilisation

One way to test this hypothesis is to study natural experiments in interdisciplinary collaboration. The topical review subcommittees of CHI represent specific bodies of theoretical and methodological knowledge. If those communities are resulting in an increasingly stable emergent set of disciplinary concepts and methods, this should be recognisable through consistent mappings to different types of disciplinary knowledge.

A convenient case study through which to test that hypothesis is the activity of the Crucible network for research in interdisciplinary design, which was established to encourage collaboration between technologists and researchers in arts, humanities and social sciences. Crucible was a strategic response to two specific opportunities in the University of Cambridge. The first is that the 50% of Cambridge undergraduates in those disciplines represent an untapped resource for the city's large technology sector[12]. The second is that it is so easy to conduct interdisciplinary research in a collegiate university, because each college brings together students and faculty across many disciplines. In the 15 years since it was created, Crucible has initiated, facilitated or coordinated 180 interdisciplinary projects, involving over 450 collaborators. The sidebar shows broad groupings of the arts, humanities and social science disciplines that have interacted with technology collaborators in these projects.

In order to test the hypothesis that the topical review structure of CHI might represent a coalescing map of disciplinary concerns (either theoretical or methodological), I classified each of the 180 Crucible projects according to the most relevant CHI review subcommittee. The use of CHI review subcommittees as an analytic lens is unconventional, and was chosen deliberately with the intention of reflecting on the disciplinary status of CHI. Of course, the projects in our sample are *not* all HCI projects: they include architecture, engineering, biotech and other technologies. The interpretation of such projects, in terms of the CHI submission categories, therefore depends on making analogies between the kinds of 'interactivity' associated with digital technologies, and the way that 'interactivity' might be interpreted in these other contexts.

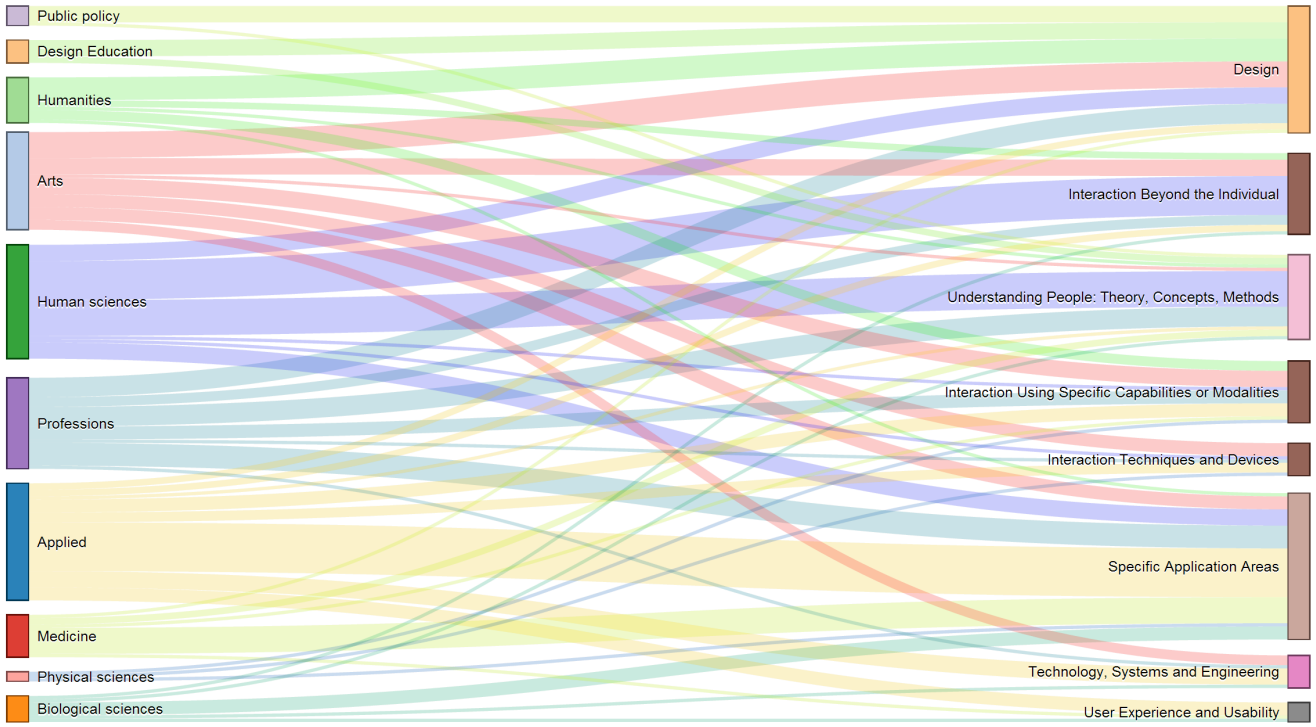

Figure 1. Mapping of 180 collaborative interdisciplinary projects to CHI topical review subcommittees

A diagrammatic overview of the resulting mapping is shown in Figure 1. The following sections discuss patterns observed.

Design (38 projects)
The design subcommittee is, unsurprisingly, a major focus for the work of a network conducting research in interdisciplinary design. This includes strategic work in design education, professions and public policy, but also critical concerns in the arts and humanities, extending to research methods, creative tools and design processes.

Understanding people (25 projects)
The majority of these projects involve collaboration with human sciences and professional disciplines. In the human sciences, understanding people is the primary concern. Technological outcomes of research may be secondary[1], but this is not a disadvantage - adopting

a goal *outside* of HCI is an opportunity for innovative triangulation on conventional HCI concerns.

Interaction beyond the individual (24 projects)
These projects extend, not only beyond cognitive theories of the individual, but beyond human sciences to the arts. The social science of artistic collaborations is an interesting feature of the UK arts funding scene, in which successive policy initiatives have encouraged both collaboration between arts and sciences, and also public participation in the creative and design process.

Interaction using specific capabilities (18 projects)
Novel interactive products are the 'public face' of computer science. For our collaborators, the utility proposition is a technological solution of value in their own work. From our perspective, the application domain offers an opportunity to test our technical approaches and design understanding more widely. An ideal collaborator is interested in the opportunity for new insights or unanticipated outcomes that might not count as 'research'. I return to this question later.

Technology, systems and engineering (10 projects)
Crucible has not been responsible for many systems engineering projects. These require dedicated technical effort, relatively substantial research budgets, or significant entrepreneurial investment.

Interaction techniques and devices (10 projects)
The range of projects creating new interaction technologies is rather similar to that of systems and engineering projects. The economic dynamic here is not so much the scale of engineering effort, as the need for specialist facilities and materials often used to create novel devices.

User experience and usability (6 projects)
The professional methods arm of CHI, mirroring the role of the UX expert in a multidisciplinary team, is not a major feature of the portfolio.

Specific application areas (44 projects)
The largest subcategory of Crucible work, if it were to be submitted to CHI, would be sent to the 'applications' subcommittee. However, even this applied work is uniformly spread across the portfolio of collaborating disciplines.

The portfolio used for this analysis cannot be expected to demonstrate the full breadth of HCI research. Originating from a single institution, and pursuing the strategic agenda of a small number of core researchers, Crucible will clearly be constrained in some respects. Nevertheless, the 15 years for which the network has operated offers a sample period that is comparable to the 20 year survey of Liu et al, and can be used to test the hypothesis that HCI research might converge on particular topics over such a period of time. Sampling only a single organisation introduces bias, but in a direction that should result in *greater* convergence than might be expected across CHI as a whole. In fact, the opposite seems to be the case. Rather than convergence over 15 years, Figure 1 does not show any sign that particular disciplinary knowledge bases have converged within specific topical areas.

Innovation through Inter-Disciplines

This persistent lack of convergence, demonstrated both in the bibliometric analysis of Liu et al, and in the analysis of my own extended portfolio, raises the question: What if the purpose of HCI were not to develop and maintain a stable body of knowledge, but rather to be the catalyst or source of innovation? Perhaps the function of HCI is

Methods to characterise interdisciplinary innovation[3]:

Snowball sample: leading interdisciplinary innovators nominated other leaders in multiple phases, identifying 500 individuals.

Research workshops: 16 expert witnesses from different sectors, academic backgrounds and professional roles, reflected on leadership experiences in personal case studies (as in [2]).

Field visits: contextual interviews in prominent interdisciplinary sites such as contract research companies and collaborative media arts organisations.

to be questioning, provocative, disruptive and awkward in relation to other disciplines - particularly in relation to those disciplines that underlie our professional affiliations. Might the essence of HCI be better characterised as a set of collaborative processes and attitudes; a practice-based style, more akin to that of journalists and theatre producers rather than a theoretical scientific discipline?

Despite the appealing prospect that we might eventually converge on a mutally agreed set of research themes, CHI is actually driven by the expectation of innovation, for example advocated by Stolterman and Wiberg as a criterion when choosing a theoretical basis for concept-driven research [19]. Those who sponsor our research also expect innovation. Government policy seeks future economic advantage via breadth and exploration rather than stability and specialisation, with knowledge brought to bear in new ways that respond to technological opportunities and human challenges [5,10,15].

As an exploration of this dynamic, we conducted a policy study funded by Nesta, the UK National Endowment for Science, Technology and the Arts. The work was commissioned by the Nesta team responsible for creating interdisciplinary programmes, and had the specific objective of exploring the relationship between interdisciplinarity and innovation in the UK. A full report is published as [3].

The goal in this study was to explore the relationship between interdisciplinarity and innovation in a manner that did not impose any prior assumptions with respect to the definition of those terms. We adopted the phenomenological research strategy of bracketing the words, in order to respond to the ways that they are used by a self-identified constituency. We engaged with this constituency through the triangulated methods summarised in the sidebar.

Our key finding was that the relationship between interdisciplinarity and innovation is to do with unexpectedness. Disciplinary research sets up a framework that defines and thus constrains the outcome of the research. Innovative research, on the other hand, is research whose results were not expected. In one sense, this is a well-known dynamic in academic research. Academics are often chafing against the demands of funding agencies that wish to assess the relative value of grant applications by specifying in advance what discoveries will be made. Less well-understood is the dynamic by which it may not even be possible to describe the nature of the research question. Well-posed research questions can only be well-posed in terms established by existing bodies of knowledge. Yet our informants in this project often drew attention to the ways in which their interdisciplinary research answered questions that did not even exist at the outset. Rather than crude metaphors of innovation through 'cross-fertilisation', or 'breaking down silos,' innovation arises where disciplines challenge each other's epistemological standpoints.

This challenge is achieved, practically universally, through collaboration - between members of a team who hold different understandings of the world, and work together to attain a new alternative. It is clear from this dynamic that interdisciplinary innovation cannot arise through the subordination of one discipline as a stable 'service provider' to the other [1]. It is necessary that any partner is able to challenge

assumptions resulting from a disciplinary standpoint. Once again, we see that a common metaphor for interdisciplinary work is insufficient - it is not simply the case that disciplinary specialists 'speak different languages', and need a 'translator' in order to be able to understand each other. On the contrary, skilled researchers are often skilled communicators, easily able to share their understanding in a register appropriate to a new audience. The challenge, as we identified it, is that different disciplines are actually setting out to achieve different things. They talk at cross-purposes because they do not appreciate how different the intentions of their collaborators might be.

These insights into the nature of interdisciplinary innovation highlighted the need for time and resources in which members of the team can accept that they are 'wrong' – in need of a new understanding. Humility is invaluable, but it is never easy for skilled professionals to accept challenges to their understanding. Since professional skill is acquired within a discipline, innovation from elsewhere is always challenging. The response often occurs over a period of years rather than months - during which it may turn out that the original objectives of a project must be abandoned in the light of the understanding gained.

Although these processes are collaborative, we found that the role of the leader was critical. The leader must articulate a vision that persuades patrons and publics to commit the necessary resources, and also recruits team members to a shared moral purpose that overrides the commitments of their disciplinary training. More surprisingly, the leader must then be able to re-orient the whole enterprise when unanticipated opportunities arise. The personal attributes and skills that enable people to act in these different ways are extensively documented in our full report[3]. One notable finding is that certain professions - theatre producers, product designers, journalists - appear to be particularly effective in nurturing these pragmatically collaborative leadership techniques.

However, as with these other professions, some more mundane managerial skills are also required. In an unavoidably risky process, management of risk is a high priority. This cannot take the form of *removing* risk, which would render the innovation process meaningless. Instead, necessary risk must be managed as in a financial portfolio - but here the portfolio is an intellectual one, with a mix of methods, theories, and discursive or practical styles.

These findings resonate with the advice given by Kim [11], with regard to the working styles and personal characteristics necessary for effective interdisciplinary collaboration. They also provide a counter to the analysis of Liu et al [13], in drawing attention to the ways that a stable theoretical and methodological core need not the most essential element of an effective and innovative research enterprise.

The Value of HCI as an Inter-discipline

This paper has suggested that HCI might be defined, not as a subject in itself, but in relation to other disciplines. There is a body of expertise that helps us understand what this might mean – in terms of the sociology of knowledge, and history of science. This is not to advocate that HCI is a-theoretical – on the contrary, there is an essential role for both theory and method to offer rigorous and sustained resistance to the theories and methods of our host discipline(s).

However, collaborative engagement with a wider range of academic disciplines draws our attention to the fact that whereas some disciplines are routinely reflexive, and easily able to articulate their epistemological standpoint or methodological choices, others find such reflexivity unfamiliar or even threatening. Unsurprisingly, this occurs most often among our scientific and technical collaborators rather than those in the arts or social sciences.

On the other hand, when working with those trained in the humanities, although they may be willing to question technical assumptions, skepticism of scientific principles can be an obstacle to conversation. The agenda of design is a challenge to academics in all disciplines: in what ways might a critical observer participate in an intervention, and to what extent must they engage with the technical practice that enables such intervention?

I suggest that these are the key skills of the HCI community: willingness to engage with technical practice and the desire to make interventions. Doing so in a way that is consistently effective and innovative requires both collaboration and reflective practice. If the goal of HCI were to be a reflexive centre of socially engaged critique, then a creative and design-oriented perspective might encourage a core commitment to curiosity and playfulness rather than earnest self-analysis.

Rather than defining a discipline independent of established critical perspectives, with its own theoretical cores and concerns as sought by Liu et al [13], the alternative is that technology becomes a lens through which to understand being human in a changing world. These more universal aspirations point to the *centrality* of HCI, not as another discipline (or sub-discipline of computer science), but rather as a context in which to realise our identity through creativity and experience, our social relations in the modern cultural setting, and our embodiment as a fragile component of technosystems.

When analysing HCI as an inter-discipline, it is essential to consider how reflexivity is accommodated within the community of practice. For many years, reflexive critique of CHI was carried out in alt.chi sessions rather than in the main conference, as reviewers found it difficult to see the value in challenges to the achievements of the community. More recently, the opportunity for this type of reflexive critique is allocated to design - the only category that includes the word 'critique' in the remit of its 2015 review subcommittee, and incidentally also the only category to use the word 'theory' in its remit paragraph. Critique is often uncomfortable – might it be the case that 'design', as with alt.chi in the past, has become a ghetto for reflective practice, enabling a business-as-usual approach to the established questions that will provide the basis for a bibliometrically validated scientific career?

As an alternative, I have argued that HCI is not, in its essence, a scientific discipline – it is not about prediction (of user behaviour or market opportunity), invention (of novel product features), evaluation (of technical claims), or process (for managing product development). When it engages with other disciplines, it does not straightforwardly derive theoretical implications for design [6], but rather intellectual resources and practical modes of critical engagement. HCI is not about static knowledge, but ways of deploying and engaging with knowledge in a technological setting. If so, HCI should not aspire to be a discipline, measured through bibliometric convergence on core findings, but rather a mode of challenge and provocation – although one that is characterised by

humility, playfulness, invention and rigorously honest reflection rather than confrontation between alternative disciplinary frames.

References

[1] Barry, A., Born, G., and G. Weszkalnys. Logics of Interdisciplinarity. Economy and Society, 37(2008), 20-49.

[2] Blackwell, A.F., Eckert, C.M., Bucciarelli, L.L. and Earl, C.F. Witnesses to design: A phenomenology of comparative design. Design Issues 25(2009), 36-47.

[3] Blackwell, A.F., Wilson, L., Boulton, C. and Knell, J. Creating value across boundaries: Maximising the return from interdisciplinary innovation. NESTA Research Report CVAB/48, 2010.

[4] Burt, R. Brokerage and Closure: An Introduction to Social Capital. Oxford University Press, 2005.

[5] Cox, G. Cox Review of Creativity in Business: building on the UK's strengths, 2005. HM Treasury.

[6] Dourish, P. 2006. Implications for design. In Proc. CHI 2006, pp. 541-550.

[7] Fincher, S. & Petre, M. Computer science education research. London ; New York: Taylor & Francis, 2004.

[8] Galison, P. Image & logic: A material culture of microphysics. University of Chicago Press, 1997.

[9] Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott, and M. Trow. The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies. Sage, 1994.

[10] HM Treasury. Science and innovation investment framework 2004-2014

[11] Kim, S. Interdisciplinary Cooperation, in Laurel, B., ed., The Art of Human-Computer Interface Design. Addison-Wesley, 1990, pp. 31-44.

[12] Kirk, K. and Cotton, C. The Cambridge Phenomenon: 50 Years of Innovation and Enterprise. Third Millennium, 2012.

[13] Liu, Y. Goncalves, J., Ferreira, D. Xiao, B. Hosio, S. and Kostakos, V. CHI 1994-2013: mapping two decades of intellectual progress through co-word analysis. In Proc. CHI 2014, pp. 3553-3562.

[14] Lloyd, G.E.R. Disciplines in the Making: Cross-Cultural perspectives on elites, learning and innovation. Oxford University Press, 2009.

[15] National Academies (U.S.). Facilitating Interdisciplinary Research. National Academies Press, 2005

[16] Schön, D. The Reflective Practitioner, How Professionals Think In Action, Basic Books, 1983

[17] Star, S.L. and Griesemer, J. Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. Social Studies of Science 19, 3 (1989), 387–420.

[18] Stokes, D.E. Pasteur's Quadrant – Basic Science and Technological Innovation. Brookings Press, 1997

[19] Stolterman, E. and Wiberg, M. (2010). Concept-driven interaction design research. Human-Computer Interaction 25(2), 95-118.