

STATUS OF HUMAN BEHAVIOUR IN DESIGN RESEARCH: A REVIEW OF ICED AND DESIGN CONFERENCE PROCEEDINGS

K. Lauche

Keywords: human behaviour in design, design thinking, teams, organisational aspects

1. Introduction

This paper focuses on the state of the art of empirical research on human behaviour in design, i.e. descriptive studies of what designers do, how they use what they know, when they perform best, and how they work together with others on a task. While studying designers is no more than one of the sub-disciplines of design research, a thorough understanding of human behaviour in design will undoubtedly present a better basis for educating design students and improving current practice.

Traditionally design, aimed at producing new things, and science, aimed at understanding the nature of things as they exist, have been separate fields and are only gradually converging into a field of design science [1]. The remit of design science comprises empirical studies of actual practice, the development of methods and tools for improving this practice, and the implementation of these methods. Increasingly the human behaviour of designers is regarded as a key ingredient to the use of knowledge and the application of procedures and methods. The challenge for design research is that it not only requires a decent understanding of designing, but also a good grasp of research skills and background knowledge about complex human activities in practice, such as psychology, sociology and management. While it is unlikely that every single researcher can be an expert in both areas, it will be of crucial importance for the community as a whole to maintain active links into both domains if the field is to progress.

The purpose of this paper is to examine to which extent the empirical design research presented at previous design conferences has embraced psychological theories and findings about human behaviour, and to identify so far under-researched areas. It will also discuss means of propagating existing links between the two communities and bodies of knowledge.

2. Human behaviour in design

If we see designing as a special form of human behaviour, proven psychology knowledge should help to advance empirical design research. There are four major areas in which psychological research can be relevant to design:

1. Designing as problem solving refers to individual aspects such as thinking, creativity, visual cognition, memory, knowledge, learning, expertise, but also individual differences, emotion and motivation;
2. Designing as a social process refers to team aspects, social cognition, shared mental models, team interaction in ad hoc, distributed, co-located, interdisciplinary etc. teams, and client interaction;

3. Designing as work addresses the organisational aspects of product development and design management, job design, work environment, leadership, culture and organisational change;
4. Humans as users of design refers to ergonomics (such as human body size and physiology) as well as cognitive and social aspects such as the context of the use, user involvement, and participatory design.

The hypothesis when starting this review was that the current state of empirical design research is characterised by some interest and collective knowledge about problem solving since the famous protocol studies and observations of designers of the 1990s [2]. However I assumed that there would only be a selective appreciation of the original psychological literature on cognitive processes and that emotional and motivational aspects as well as inter-individual differences would be underrepresented. My impression from the past conferences had also been that teams have become a fashionable research topic after years of integrated product development promotion and teamwork in industry. However, I postulated that the research would make limited use of the existing body of empirical research on team interaction and performance in psychology.

In terms of design as work, my hypothesis was that most empirical design research has ignored the fact that designing is not simply problem solving but also a specialist occupation within the division of labour in a company. The organisational reality of design work was assumed to be underrepresented. I also postulated that the engineering design community would be largely disconnected and unaware of the design management community and recent developments in work psychology.

3. Method of review

The papers included in this review were those of the proceedings from the Dubrovnik 2000, 2004 and ICED 2001, 2005 conferences with a total of 1019 papers. It continues a tradition of meta-analysing these conference proceedings for the purpose of feedback to this community and is not intended as a complete review of all literature in the area. Previous meta-analyses mainly aimed to broadly categorise the research areas and used automated keyword searches. In this case, a more qualitative approach was chosen in order to evaluate how psychological topics were being addressed.

Upon reading each paper, I evaluated whether it addressed psychological aspects of design or human behaviour based on its title, the keywords and the content. For ICED'05 the decision was based on the abstracts in the printed proceedings, and only those papers that appeared to address psychological topics were then accessed in their full length to determine their epistemological status and types of references used. It is possible that in some cases the abstract masked a hidden psychological content and my figures underestimate the actual number of contributions. The following rules for inclusion were applied:

- Methodological papers were included if they contained a report on how the method had been applied in practice.
- Educational papers were included if they described student practice in design but excluded if they only reported contents of a curriculum.
- Papers about tools were included if the tool was either based on empirical research or psychological theories, or had been extensively tested as to allow insight into designing with the tool.
- Design management papers were included if they considered organisational psychology or reported a case study but excluded if they discussed global trends without any attention to actual design activities.
- Papers about humans as users of products had to involve actual users and/ or address psychological aspects of user perception or practice. Ergonomic models of merely physical properties of human users were not included.

I then determined which of the four aspects of human behaviour the paper addressed, whether it was based on an empirical study, and what kind of literature was being cited. Multiple codings were possible; for example, a paper could address individual and team aspect as well as introducing and evaluating a tool for collaboration. The literature coding included psychological textbooks and journal papers as well as design research, as long as it made some reference to previous empirical work and

did not solely quote prescriptive textbooks. Other sources such as ergonomics, management, education, CSCW and HCI were also recorded. Any reference to previous work was coded as one entry; no effort was made to evaluate whether the listed references were appropriate or exhaustive.

4. Results of review

The findings from the review will be presented in terms of the overall picture, the content of what was being researched, the authors and research groupings involved, and type of research as well as the acknowledgement of psychological literature.

4.1 Overall picture

The overall tendency was a rise in contributions with psychological content from 11% at the Dubrovnik 2000 conference to 27.6% and 26% in 2004 and 2005. The sharp rise from 2000 to 2001 is likely to be due to the different foci of the two conferences. Traditionally the Dubrovnik conferences had been more engineering-oriented than ICED, and the increased interest in human behaviour that marked the ICED conferences around 1997 and 1999 presumably arrived on scene at the Dubrovnik conference in 2002. The Dubrovnik 2004 conference not only boasted the highest percentage but also featured a workshop on human behaviour in design and the first and only plenary presentation on psychological aspects [3].

Table 1. Percentage of papers with psychological aspects of designing

	Total papers	Papers with Ψ content	%
Dub 2000	134	15	11.2%
ICED 2001	325	78	24%
Dub 2004	232	64	27.6%
ICED 2005	328	86	26.2%
Σ	1019	243	23.9%

The percentage of contributions with psychological content does not seem to rise any more in recent years, which would indicate that a certain degree of saturation in human behaviour research has been reached.

The quality of publications was rather mixed: from sophisticated studies, which could easily be revised into a journal publication, to papers with little contribution to knowledge, an often incomplete grasp of English and very limited grounding in the literature. Across all papers in the four conferences, there was a large amount of “theory of everything” papers, which contained their authors’ view of what designing, or collaboration, or education was without any empirical evidence how this view had been developed. While theoretical works are certainly valuable and necessary for any academic discipline, the merit of yet another theory of design remains questionable if it is not clear how the new theory advances our understanding and ability to support and predict design activities. In some cases, the title or keywords seemed to indicate psychological content but the paper failed to deliver that promise (partly a problem of terminology for words such as “learning”, which could mean improvements in design without any human learner involved). In the majority of papers, the concept of human actors was that of an abstract, generic designer or user, which is likely to be over generalised and simplified. It is unlikely that these generalised statements will progress our understanding of what designers do and how we can support them.

4.2 Research topics

In terms of the research topics (Fig. 1), a large proportion did indeed deal with cognitive aspects of designing, namely in terms of creativity, ideation and education, but also method use, sketching and reflection. Motivation and inter-individual differences were under-represented as expected but not non-existent: One paper by Leifer *et al.* addressed the motivation to document, another by Cowdroy *et al.* dealt with inter-individual differences. ICED’05 featured an encouraging breadth of topics.

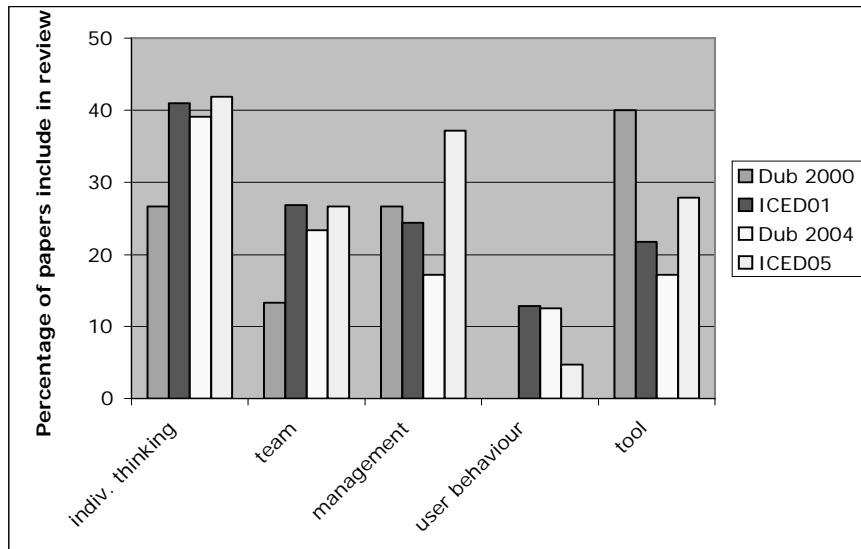


Figure 1. Topics of human behaviour in design addressed in the selected papers

The papers on team aspects mostly reported empirical studies of design teams, often in educational contexts but also in industry. The research aimed to support teamwork and collaboration but it also described the process and analysed difficulties in distributed or cross-disciplinary work. So the hypothesis that there would be an over-optimistic bias towards teams was not confirmed – teams are regarded as a matter of fact in industry, or used as a practical instrument for teaching large numbers of students. More awareness of social psychological research could help to understand and manage the challenges of teamwork and work psychology would provide a basis for structuring the task more adequately collaboration.

Papers in the category design as work largely addressed design management issues, such as strategy, innovation, success factors, organisational learning, knowledge management, target costing etc. Particularly ICED’05 has seen an increase in contributions on design management – maybe encouraged by the title of the conference or as part of a general trend. The good news was that there seems to be more overlap with the design management community than I had anticipated. The not so good news was that only one paper in each conference dealt with actual work processes of designers, and the penetration with work psychology was as marginal as I had anticipated.

The main topics in the category of user behaviour were inclusive design, product evaluation by users, and differences in designers’ and users’ concepts about a product. At least some of researchers seemed to be aware of the large body of literature on participatory design that exists in the HCI and CSCW community.

4.3 Authors and research groupings

In terms of the origin of contributions with psychological content, there was a wide spread across institutions and countries but one could also identify some larger groups who regularly published in this area, namely Cambridge, Delft and Munich, followed by Berlin, ETH and KTH. Table 2 below lists all entries of institutions that appeared at least twice at any of the conferences and at more than one conference. The latter criterion also excluded institutions like Loughborough and Melbourne who contributed substantially but only to the one conference in their country.

The listing was compiled according to first authors and therefore obscures any collaborative efforts. It does however indicate research grouping with a higher degree of continuity, i.e. professorial staff with the resource of doctoral students (unlike the cases of Aberdeen and Bamberg where the move of one individual brought the entire design research community in that institution to an end).

Table 2. Contribution by institution of first author

	Dub 2000	ICED'01	Dub 2004	ICED'05	Total
Cambridge		8	5	4	17
Delft	2	5	2	5	14
Munich		4	4	5	13
Berlin		3	3	4	10
ETH	2	4	1	2	9
KTH	2	4		3	9
Darmstadt		1	4	3	8
Stanford		5		2	7
Lyngby		1	2	3	6
Sydney			2	4	6
Aberdeen		3	2		5
Grenoble		1	2	2	5
Napier		2	2		4
Strathclyde		2		2	4
Bamberg		2	1		3
Chalmers			3		3
Helsinki			2	1	3

4.4 References to psychological literature

From ICED'01 onwards, a large amount of the papers included in the review contained some form of empirical evidence from actual investigations of design activity (see fig 2). It also became increasingly good practice to refer to previous work from empirical design research (for ICED'05 the value is almost 90%), which is an encouraging sign of consolidation for the design research community.

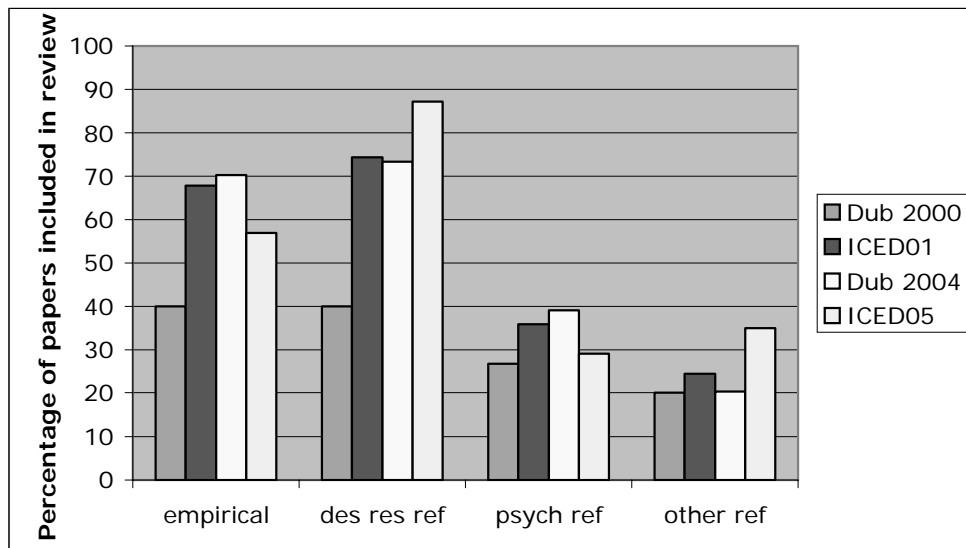


Figure 2. Sources of evidence and previous work cited

However, the reference to psychological sources is much lower and no longer increasing. In most cases, the reference list contained only one psychological source, often a textbook or theoretical

framework such as Kolb's theory of learning or De Bono's guidebook on creativity, which hardly constitute the state of the art of psychological research. This means that the design research community runs the risk of wasting resources in conducting research for which there is already a proven body of knowledge available, and does not train researchers to acknowledge their sources. Apart from a few encouraging examples where a transdisciplinary body of research specific to designing has been created as the result of long-term collaboration between designers and psychologists (such as between Darmstadt, Munich and Bamberg, and between Berlin and Dresden, as well as in Cambridge), only very few papers gave the impression that their authors kept abreast of the psychological literature.

5. What design science could learn from psychology

The review has found that there is a considerable body of research on psychological aspects of designing (about a quarter of all papers in both conferences), yet the reception and acknowledgement of up-to-date psychological research was rather disappointing. If there is room for improvement, what could design science possibly gain from a more in-depth study of psychological resources?

One of the main benefits would be an understanding of humans as conscious actors with intentions, needs, and a history. From that perspective issues such as the motivation to design and to use, the perception and interpretation of a given situation and inter-individual differences in personality and ability could be addressed as determinants of design behaviour. A more design-relevant concept is that of the redefinition of the task in work psychology: anyone who receives or sets themselves an assignment interprets the requirements it implies, and relates them to their own knowledge and skills and the expected benefit in terms of meeting their personal needs [4]. This comparison serves to motivate people to pursue a task even if they encounter difficulties on the way, and to make sense of their work. However differences in individual redefinitions of a task can also lead to conflicts between project members or client and designer if they are not explicated and addressed.

Design science could also benefit from the heightened awareness of methodological questions. As psychologists always have the problem that their object of inquiry is another human being, they have become more conscious of what constitutes knowledge and which precautions can be taken to achieve justifiable conclusions in the absence of objective facts. Since those studying designers face the same issues, an education in social science research methods at doctoral level along the lines of what Blessing and colleagues have proposed [5, 6] would certainly be desirable.

A lot of the empirical papers relied on interviews and questionnaires as the main research methods. While interviews have the advantage of capturing a lot of relevant information in a relatively short timeframe, they can only ever be as good as the informants' ability to reflect and report on the issue in question. As human memory is always a reconstruction of what was perceived as relevant and never an accurate reproduction of reality, the findings might be distorted by participants' perception. The value of the results will also depend on the selection of interviewees, an issue that may have been considered but was typically not properly justified in the papers reviewed here. The subjective reports may be useful when evaluating the acceptability of a product or design education programme but they are not necessarily the best outcome measure for quality or success.

Apart from the extensive protocol analysis studies of the 1990s [2], very few papers deal with actual behaviour in detail. In that respect, design science could draw on the wealth of different methods for studying cognition and behaviour in psychology. There are numerous psychometric tests to measure, for example, cognitive styles or personality differences, which could explain motivational differences, learning outcomes or preferences for different design methods. Very few design researchers seem to draw on the expertise of psychologists to design experiments for testing alternative hypotheses about what designers do individually or in teams. A typical set-up would compare novices and experts, or different educational approaches, or different tools or resources in terms of the impact on predefined process and outcome criteria, such as the number of iterations, the fulfilment of requirements or the quality of the solution. While experiments are usually unsuitable to study complex behaviour in its natural context, they can help to investigate specific aspects of designing or use quasi-experiments in field conditions [7].

In terms of team interaction, design science could draw on social psychology for understanding why teams sometime struggle or fail to achieve what they are supposed to do [8]. There are models of team performance in complex work environments that are likely to apply to the domain of design work, such as the type of task. In additive tasks where all members perform the same act such as rope-pulling, groups can outperform their best-performing member. For tasks with an obvious correct solution, the group performance typically matches that of the best performing member, and if tasks are conjunctive the total performance is likely to depend on the weakest link. Design tasks are more likely to be conjunctive than additive, so teams are only likely to be as good as the tasks have been matched to their members' abilities. In general the psychological research on idea generation in teams has emphasized the detrimental effects of social loafing and coordination, but more recently proposal have been made to make brainstorming more effective [9]. However there is also evidence from integrated product development that teamwork can help to shorten overall project time, and it is still an open question for design research to identify which forms of collaboration are most suitable for which aspects and tasks in design.

In terms of work and organisational aspects of design, there has been some recent work on leadership [3], but a lot of the design management research could benefit from a closer look at leadership theories [10]. The human-centred perspective on working conditions has a long history of assessing the impact of the organisational condition on job satisfaction, performance and health implications such as stress and burnout. Only recently has this perspective been applied to the domain of design, and more substantial longitudinal studies are needed to understand the implications for the work of designers work [4, 11, 12].

6. Signs of a paradigm change?

Is the gradual change that can be seen in these findings an indication of a paradigm change in Kuhn's sense of scientific revolutions [13], a change towards human behaviour in design becoming a normal part of design science? There probably already was a paradigm change when empirical investigations of design activity gained momentum in the 1990s, but not to the extent of replacing one paradigm of normal science with another one completely. Similar to the historical revolutions Kuhn described in his seminal book, it has been a gradual change partly influenced by new proponents entering the field. But design science is also characterised by the co-existence of parallel schools; like social science it is not at the stage of normal science in Kuhn's terminology in that only one paradigm of questions and methods would be deemed appropriate. Pahl & Beitz [14] had the status of a defining textbook for the prescriptive tradition of design methodology, and the material of the Delft protocol workshop in 1994 [2] serves as a paradigmatic reference even in ICED'05 papers. But no comparable monograph has since been written that has achieved textbook status throughout the community.

To progress the field further, more transdisciplinary work is needed, both in terms of actual research and strategic efforts at policy level in order to establish an authority to define good and bad science. If Kuhn's concept of normal science is to be believed, then the existence of professional bodies, some influence on funding bodies and standards for PhD research are important instruments for obtaining this authority as a proper science.

If the contribution of psychology is to more than an ancillary science then doing research on designing has be attractive for an academic career as a psychologist as well. So far the interest from psychology in designing is rather limited – the domain is perceived as complex and technical in nature, it does not lend itself to clear-cut laboratory experiments and would require a holistic rather than compartmentalised approach to psychology itself. Psychological research is notoriously empiricist: only data counts, and discussions centre on how it was obtained and analysed, not about the theoretical implications. Conferences such as ICED and Dubrovnik are typically not regarded as appropriate outlets for psychologists to publish, and it might need other mechanisms to enable cross-fertilisation. The journal *Design Studies* and the DTRS symposia seem to have been successful vehicles of interdisciplinary dialogue and accretion of knowledge. Co-supervision of PhD students with colleagues from both design science and psychology could be another instrument to foster mutual learning and to bring up another generation of researchers on human behaviour in design. And maybe the time is there for a textbook on how to do proper empirical design science.

References

- [1] Cantamessa, M. "Design Research in perspective - A meta-research on ICED 97 and ICED 99", *International Conference on Engineering Design*, Vol. Glasgow, 2001, .
- [2] Cross, N., Christiaans, H. and Dorst, K. "Analysing design activity", Wiley, Chichester, 1996.
- [3] Badke-Schaub, P. and Stempfle, J. "Analysing leadership activities in design: how do leaders manage different types of requirements?" *8th International Design Conference*, Vol. Dubrovnik, 2004, pp. 1-6.
- [4] Hacker, W. "Action Regulation Theory - A practical tool for the design of modern work processes?" *European Journal of Work and Organizational Psychology*, Vol. 12, 2003, pp. 105-130.
- [5] Bender, B., Reinicke, T., Wünsche, T. and Blessing, L.T.M. "Application of methods from social sciences in design research", *7th International Design Conference*, Vol. Dubrovnik, 2002, .
- [6] Blessing, L.T.M. "What is this thing called Design research?" *Annals of the CIRP Design Seminar*, Vol. Hong Kong, 2002, .
- [7] Cook, T.D. and Campbell, D.T. "Quasi-experimentation design and analysis issues for field settings", Houghton Mifflin, Boston, 1979.
- [8] Hewstone, M. and Stroebe, W. "Introduction to Social Psychology", Blackwell, Malden, MA, 2001.
- [9] Paulus, P.B. "Groups, Teams, and Creativity: The Creative Potential of Idea-Generating Groups", *Applied Psychology: An International Review*, Vol. 49, 2000, pp. 237-262.
- [10] Yukl, G. "Leadership in Organisations", Prentice Hall, New Jersey, 2002.
- [11] Lauche, K. "Job design for good design practice", *Design Studies*, Vol. 26, 2005, pp. 191-213.
- [12] Robinson, M.A. "The development and piloting of a novel methodology for determining how designers spend their working time", *15th International Conference on Engineering Design*, Vol. Melbourne, 2005, .
- [13] Kuhn, T. "The Structure of Scientific Revolutions", University of Chicago Press, Chicago, 1962.
- [14] Pahl, G., Beitz, W., Wallace, K., Blessing, L.T.M. and Bauert, F. "Engineering Design. A Systematic Approach", Springer, Berlin, 1996.

Dr Kristina Lauche
Assistant Professor for Design Theory and Methodology
Delft University of Technology, Faculty of Industrial Design Engineering
Landbergstraat 15, 26282 CE Delft, The Netherlands
Tel.: +31-(0)15-2781945
Fax.: +31-(0)15-2787790
Email: k.lauche@io.tudelft.nl