Scope and focus in engineering design research: distance learning experience at masters level compared with ICED 99 interests

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SCOPE AND FOCUS IN ENGINEERING DESIGN RESEARCH: DISTANCE LEARNING EXPERIENCE AT MASTERS LEVEL COMPARED WITH ICED 99 INTERESTS

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1 Introduction

Much has been published on the subject of distance learning and the term e-learning has entered the vocabulary as irrevocably as e-commerce. Many universities aspire to increasing their student populations at undergraduate level through distance learning, and proposals are underway for e-Universities. This paper describes experience at the UK's Open University (OU) MSc course in manufacturing: management and technology (research module), from the perspectives of its relationship with current research in engineering design, exemplified by ICED 99 interests.

The scope and focus of MSc dissertations over a period of seven years were examined, as being representative of the many concerns of manufacturing companies, since almost all students were industrially based. Results were then compared with the scope and focus of papers accepted by ICED 99, as being representative of researchers' perceptions of the design-related concerns of manufacturing companies. A close correlation of concerns was identified in areas of process design and enabling technologies, though otherwise there were notable mismatches. Little interest was shown by manufacturing industry in meta-design and design processes. ICED researchers showed little interest in major areas of organisational technology that obsess many MSc candidates and their companies.

2 The Open University distance learning model

Distance learning using IT support for undergraduate education has been the subject of long-term research and widely reported during the 1990s by, for examples [1], [2], [3]. Much emphasis is placed on the use of the worldwide web as a delivery mechanism for educational material, under the dubious assumption that education is solely the one-way process of pumping information from a supplier: university or institute, into empty vessels: students. This perception, it is assumed, suites the needs of taught courses at undergraduate and postgraduate levels though Barnes [4] and Inglis [5] amongst others questions this view. What about the needs of masters level students engaged in research training? Can they be satisfied through distance learning? Can the worldwide web enhance their learning activities? Authors de Verneil and Berge [3] provide a comprehensive debate.

The OU, which has pioneered distance learning at undergraduate level since 1969, also offers masters level programmes which contain research activity. The MSc in Manufacturing: Management and Technology, now in its fifteenth year, has a compulsory final element of research and dissertation (known as T801), which converts the diploma qualification to a full master's degree and accounts for one third of the total effort required. Students, mostly based in industry, carry out research over a period of one academic year, within a broad framework of manufacturing concerns and present their findings in a written dissertation of up to 15,000 words.

Distance learning is frequently contrasted with 'conventional' learning as if they are distinct and polarised. Although this was the case for many years, over at least the last ten years a convergence has taken place and many features are now common to both environments. The simplified models represented in figures 1 and 2 show the polarised view, thereby hiding many refinements in common use.

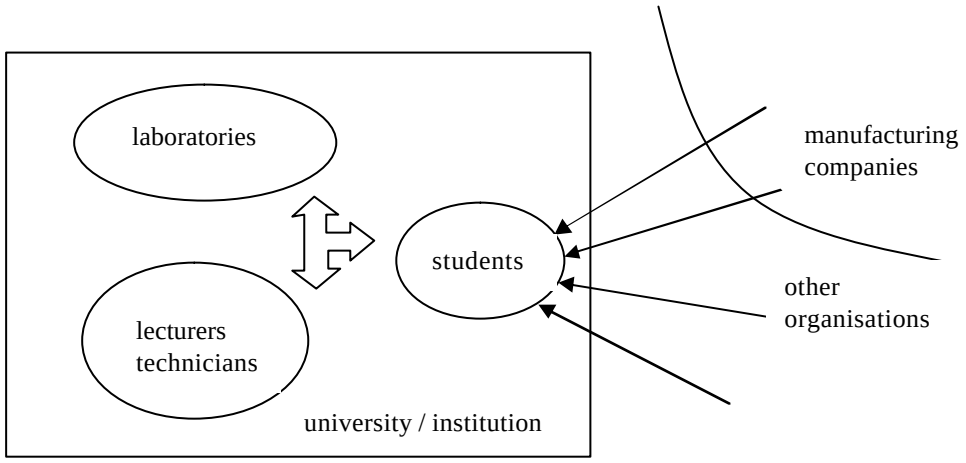


Figure 1 MSc level research at a 'conventional' university

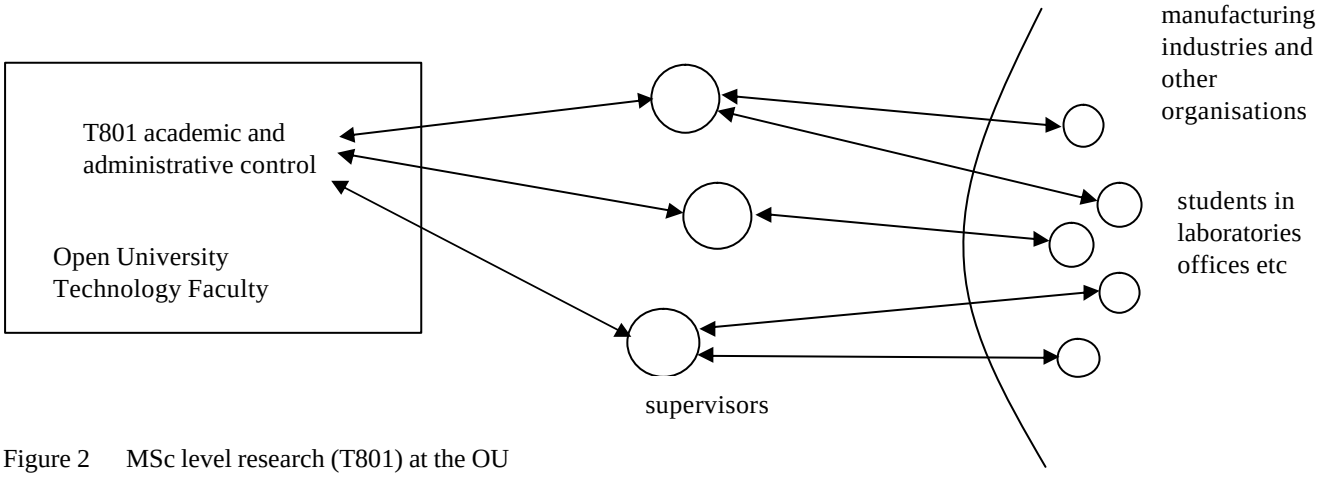


Figure 2 MSc level research (T801) at the OU

Figure 2 oversimplifies the situation in which supervisors, known as associate lecturers, situated outside the OU, industry and in universities and other organisations, guide the MSc students in their research whilst being administered, monitored and paid by the T801 administration. Supervisors meet their students, as required, and are as far as possible geographically near them as well as having

expertise close to the subject of the research. In practice there is more direct communication between students and the OU than is indicated in figure 2: in the supply of course material and in the assessment process: of research proposals, two interim research reports and final dissertations, including dissertations requiring corrections or further development. With up to 300 students at some stage of T801: (proposing research, undertaking it or resubmitting dissertations), there is a large administrative and academic task in ensuring good academic guidance from both supervisors and the T801 course team and that activities are coordinated and monitored for quality control purposes. Compared with figure 2, figure 3 shows a more complete, though still simplified, view of the communications links that operate in practice. The aim is that students receive personal, expert service which the OU can facilitate over a wide geographical area for comparatively large numbers. Most students are UK-based though others who travel in their work or who are based in other European countries have to rely more, but not exclusively, on email and telephone communications.

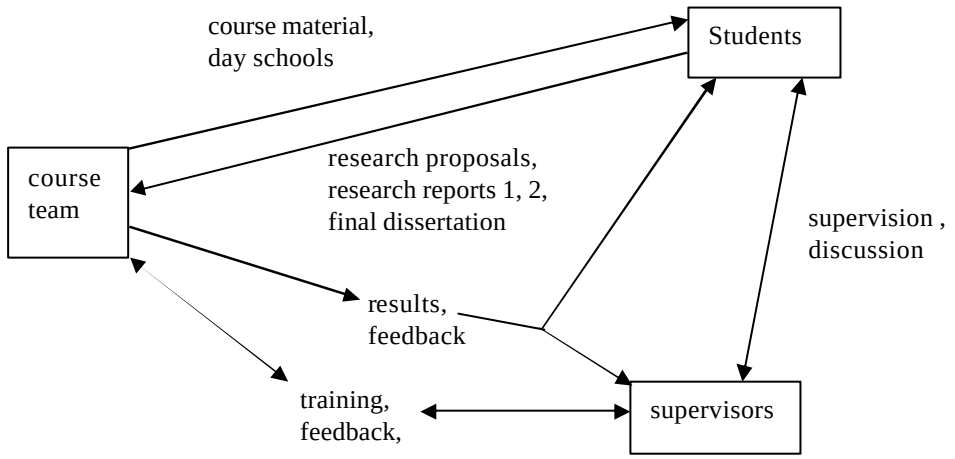


Figure 3 Communications amongst course team, supervisors and students

Contrary to expectations in the late 1990s, use of the worldwide web is minimal as a course communication medium, though it is used extensively by students seeking information about their field of research. Online conferencing, using the FirstClass™ software, of a type explained by Barnes [4] and Berge [6], is available to all students but is not widely used by T801 students. However, some students form self-help groups and find that FirstClass™ provides useful social benefits; distance learning students can feel isolated in their studies. The overall system is not without its problems but it does support a large-scale MSc programme and has been successfully developed and extended over many years.

3 Research proposition and methodology

Following ICED 99 it was noted that the conference had provided a useful cross-section of global research interests in engineering design. Similarly, it was noted at the same time that the steadily increasing collection of T801 dissertations at the OU provided a useful cross-section of industrial research interests. These represented practical issues that students encountered in their work and which they and their companies had a genuine motivation to address. The proposition emerged that a comparison of the two rich sources of information might identify potential new areas of research for

both communities. The aim of the investigation was to identify industrial issues that could be researched within the ICED framework, and issues that have been raised in the ICED forum but have not yet impacted on industrial activity. The hypothesis investigated is that there are substantial gaps in both approaches.

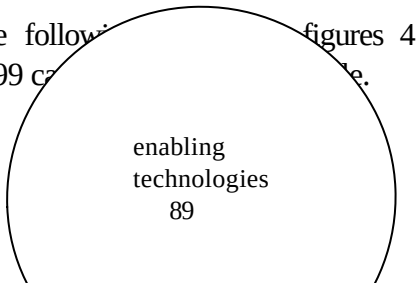
As illustrated in table 1, such disparate information sources do not lend themselves to statistical comparison. The approach taken was to identify the concerns of researchers by using the ICED topic structure used in the proceedings [7]. Even within the ICED collection it was noticeable that categorisation had not been straightforward and that significant overlaps between two, three or more categories were apparent. For example, papers listed under 'best processes' were often inextricably involved with 'competitive products' and 'enabling technologies'. The MSc dissertations were categorised, as far as possible, using the ICED approach though it was soon recognised that some modifications and additions were required. Analysis of the dissertations was carried out by reference to their titles and, in cases where the titles were insufficiently focused, to the abstract and other contents. As with the ICED 99 papers, there was considerable overlap of concerns and somewhat arbitrary decisions were sometimes made on the main concern of the research. Finally, mappings between the two groupings were produced in order to make the required comparison.

	ICED 99 Conference papers	MSc (T801) Dissertations
Approach	Emphasis on design	Design and analysis / reviews
Source material	390 conference papers	323 MSc research dissertations
Timescales	1999 conference	1995-2000 pass dissertations
Participants	90.5% academia, industrial (strongly automotive)	Nearly 100% industrial (strongly automotive) OU students
Participant roles	Mainly professional researchers	Mainly new to research, but experienced in industrial design
Industrial context	Substantial continental west Europe (CWE) , some worldwide	Substantially UK, but some CWE

Table 1 Comparison of information sources

4 Results: comparison of research category occurrences

The results are summarised on the follow[illegible] figures 4 and 5 comparing the two information sources using the ICED 99 ca[illegible]e.



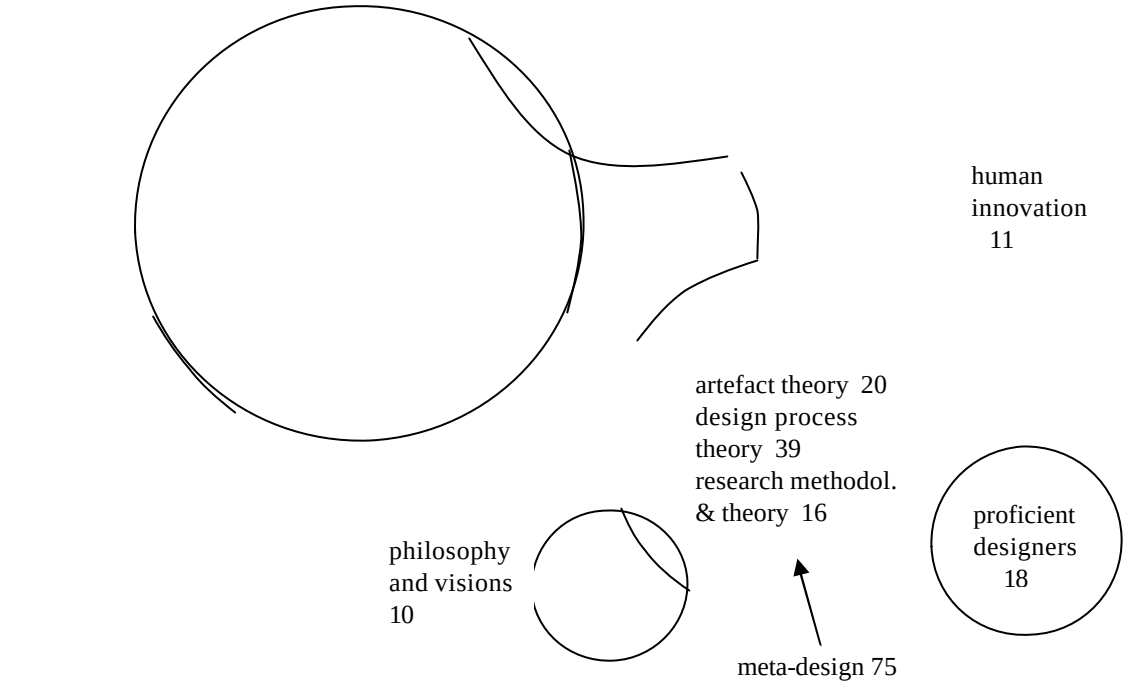


Figure 4 Distribution of ICED 99 paper categories

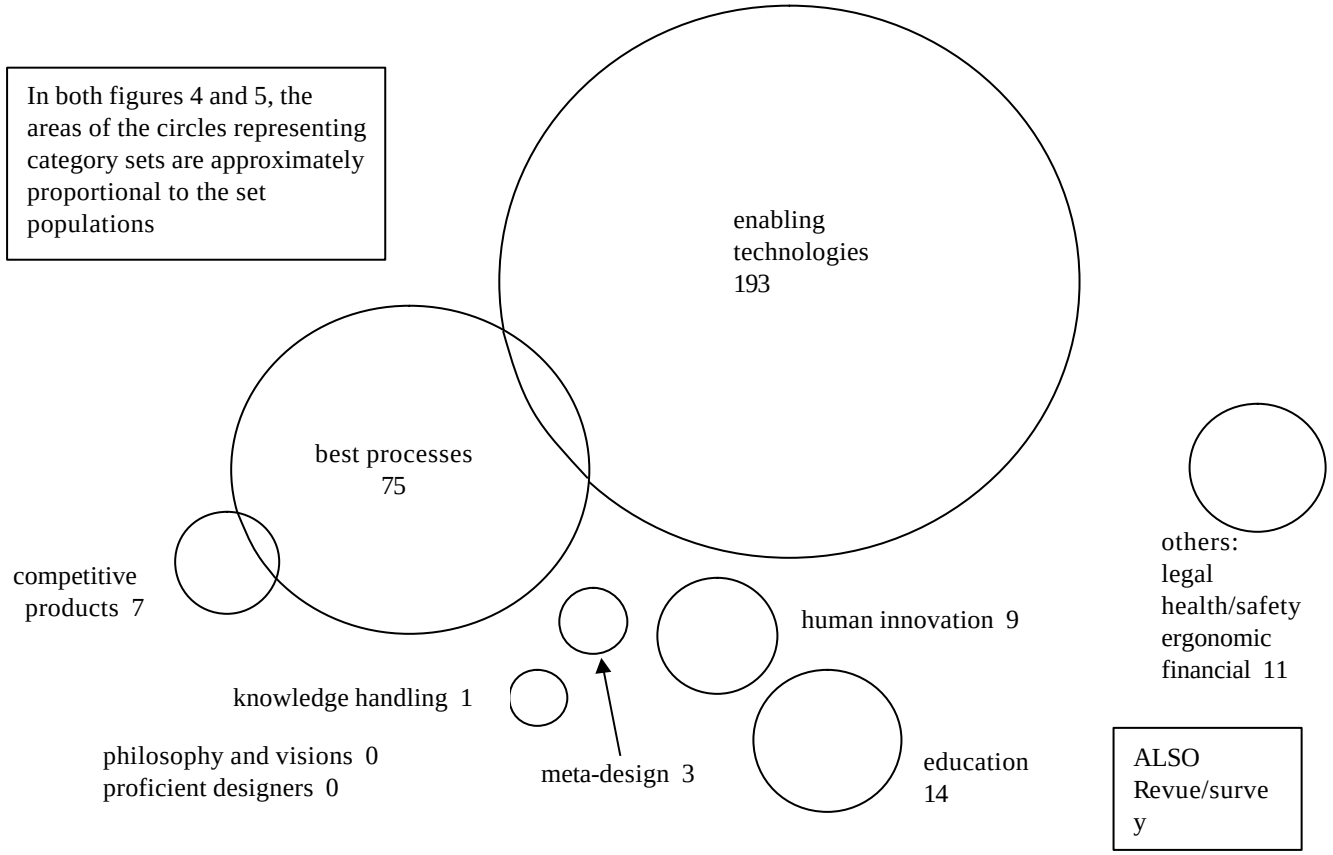


Figure 5 Distribution of T801 dissertation categories

5 Comparison of research concerns

Overall, there was some correlation in product and process design and their enabling technologies. In other areas there were significant missmatches, described below.

Processes and products Both populations showed considerable interest in the use of new materials, physical processing methods and resulting products.

Enabling technologies Although both populations showed considerable interest in a wide range of enabling technologies (23% of ICED papers, 62% of MSc dissertations), there was a considerable mismatch in emphasis and technology. In this area it was found most difficult to categorise concerns. ICED enabling technologies were strongly oriented towards software which enabled product design. Some MSc dissertations were similarly oriented but at least 60% in this category were concerned with 'organisational' technology: namely the combination of production organisation and supporting software. Industrial research seemed more concerned with design of manufacturing systems than design of manufacturing processes. A possible explanation of this mismatch is that ICED researchers are interested in future processing technologies, where industrial researchers were more concerned with the problems of improving existing means of production. Areas of interest are shown in table 2.

ICED interests	MSc interests	Interests in common
Artificial Intelligence:	Organisational Technologies:	Virtual reality
Genetic algorithms	Resource scheduling	CAD (2-D and 3-D)
Search techniques	Time-to-market reduction	CAE
Simulated annealing	Simultaneous manufacturing	Modelling
Knowledge-based techniques	Just-in-time manufacturing	Simulation
Neural networks.	Lean manufacturing	Rapid prototyping
Web-based design	Continuous improvement	
Designer workbenches	Total productive maintenance	
Paperless design	Supply chain maintenance	
Conceptual design support	Performance prediction	
Virtual collaborative design	Taguchi methods	
	Parts classification	
	Quality assurance	
	Management	
	Environmental control	

Table 2 Enabling technologies of separate and shared interest

Meta-design The ICED categories of design process theory; artefact theory; research methodology and theory were, for the purposes of this study, grouped under meta-design. The 75 ICED 99 papers on the subject indicate its significance to professional researchers. Only three MSc dissertations on the subject were identified.

Education, human innovation The subjects are of interest to relatively small numbers of both research populations.
Other ICED interests Knowledge handling; proficient designers; philosophy and visions were negligibly represented in dissertations.

Other MSc interest Legal, health and safety, ergonomic, financial aspects appeared widely in dissertations, though only in a few cases as the main subject of the research. Dissertations which were revues and surveys, often of historical interest, were few in number (10), and were discounted as not being close to the subject of design.

6 Conclusions

The areas of common interest between the sample of industrial researchers and ICED researchers are most marked in product and process design and their enabling technologies. Enabling technologies encompasses considerably wider scope in the industrial context, suggesting that the ICED concept of design is strongly oriented towards product and process design, whereas the industrial perception includes design of manufacturing systems and their management. It is noticeable that the design constraints of quality assurance, finance, legality, including health and safety, ergonomics, environmental control are major concerns for industry, though they scarcely appear explicitly in ICED papers, in spite of their importance. Perhaps there is scope here for further ICED categories. It is noticeable also that the subject of design itself is hardly touched upon in the dissertation context, suggesting that MSc candidates and their companies are more interested in solving problems using existing techniques than in investigating the techniques themselves.

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