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Revealing design complexity: Lessons from the Open University

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ABSTRACT

Design is an inherently complex activity. Design thinking is cognitively complex and design practice is contextually complex. This has implications for university-level design education which has traditionally displayed clear distinctions between the full-time and part-time undergraduate sectors, particularly in their teaching and learning strategies. However, a number of pressures and trends are evident which suggest that these two sectors are moving closer together. One of the drivers in this phenomenon is the need for students to be exposed to realistic levels of design complexity. This paper examines complexity in design and draws some significant parallels between modern design practice in general and the production of a new undergraduate course at the Open University. Both are used to illuminate design complexity. The paper suggests that some of the tools, techniques and approaches of part-time, undergraduate, distance design education might usefully be exploited in more traditional, full-time course models.

Keywords: Education, design, part-time, distance learning, complexity

1. INTRODUCTION

The case for viewing design as complex is compelling. There is increasing complexity in designed products, whether these be physical entities, virtual products or services. Paradoxically, the importance of shielding consumers from coming into contact with much of this complexity has made the devising of such products even more complex. There is increasing complexity in many of the processes of design, for example, in the range of contributions to design projects, the timing of the collaborations, the management and integration of teamwork and the generation of appropriate models. There is even great complexity in the services required to launch and maintain examples of designed products in the marketplace. This complexity is recognised by recent Government initiatives such as the Design Skills Advisory Panel¹, part of the UK's Skills for Business network. Partly because of this complexity, university-level design education faces significant difficulties today. Not only must universities engage students in developing the knowledge underpinning the complexities of designed products but they must develop skills with information and processes that are by nature emergent. Furthermore, this must take place in a climate of increasing student numbers and shrinking resources. The pressures are many and varied on traditional undergraduate design programmes where face-to-face teaching is the norm. However, there are special and unique pressures on an institution seeking to offer a distance model of design education. This paper examines complexity in the context of devising and delivering an undergraduate design course at the Open University. It highlights collaborative design activities that gave rise to a new product, in this case an undergraduate course titled 'Design and Designing'. But the paper offers more than a reflection on the ubiquity of complexity in design. It suggests that some of the tools, techniques and approaches of distance design education might be vital to the future viability of more traditional campus-based universities seeking to improve general and specific design competences.

2. THE COMPLEXITY OF DESIGN PRACTICE

It is a central tenet of the Embracing Complexity in Design cluster within the AHRC/EPSRC initiative *Designing for the 21st Century* that the practice of design is an example of complexity. This strongly held belief is partly due to the range of analytical and synthetical tasks involved in designing including defining problems, creatively generating ideas, and modelling conjecture, but it is also a consequence of the variety of competences that designing demands including managing uncertainty, overcoming conflict and working collaboratively². Modern design practice reveals itself to have a key role within the complex interactions of autonomous agents including clients, suppliers, managers and representatives of the likely users. This is compounded by the diversity of contexts within which the various branches of the design profession operate - ranging from graphic and fashion design to mechanical engineering and architecture. Put these together and one has a strong case for viewing design thinking and design practices as examples of complexity.

While modern design practice displays complexity much human design activity has always been complex. Whether undertaken by individuals or groups, problems need to be formulated before they can be resolved, and the processes of

resolution involve prioritizing and optimizing. Designing also requires knowledge and the ability to reconfigure knowledge in order to meet requirements and take advantage of opportunities. Since the industrial revolution design has increasingly become a process of specification involving contact with an increasingly diverse range of collaborators. This era saw the separation of the processes of devising and planning from the processes of making. Today there are vastly more stakeholders in the products of design. For many involved in the professional world of design today the traditional cognitive abilities are accompanied by a competence with innovation, management, communication, legislation and the ability to respond to pressures to reduce time to market. Control of design information has become as important as generating design information. Modern designing has become more than multidisciplinary; it requires designers to immerse themselves in the domains of other stakeholders including users, retailers and manufacturers. Such interdisciplinarity³ is one of the indicators of an increasing complexity in design practice today.

Design is both a constructive, creative, synthetical activity and a reactive, reflective, analytical activity. It is also a highly visual discipline. Many of the computer based design support tools currently on the market seek to address precisely these capacities and preferences of design practitioners and clearly many of the tools for computer supported design team working have proved effective, enabling new types of remote collaboration. Commercial organisations and universities have variously evolved new combinations of synchronous and asynchronous modes of computer mediated collaboration.^{4,5} But it is equally clear that some designers have preferences for face-to face meetings at certain times, some prefer to sketch on paper when the tools for computer sketch modelling exist and they often need times of personal reflective synthesis when resolving problems.

So modern design thinking displays a cognitive complexity and modern design practice displays a contextual complexity. It is the development of a competence with these that must occupy undergraduate design education today. However, there are many obstacles to curriculum development for universities.

3. PRESSURES ON UNIVERSITIES

A case can be made for viewing design education as a complex activity. Partly this is a direct consequence of design being complex but education has its own complexity, fed by broader social, economic and technological factors today. Most design curricula at university level seek to gradually expose students to the complexity of the discipline. Novice students are given simplified models of the design process in order for them to develop a conceptual overview and to allow them to map what they have already perceived onto a broader framework of activities and responsibilities. Gradually students are exposed to complexities, primarily through project work which has been a core learning tool in design education for nearly a century. Simple projects, set up to mirror simplified models of design, give way to more complex individual and team projects where iterations and outside influences require students to develop a more fluid and flexible notion of the design process model. But even the best project work can harness students to a conceptually synthesised version of designing. Marking schemes, criteria of assessment, and benchmarking all act to distill the complexity of designing into assessable components. If students are to develop modern, high-level design thinking skills, for example an understanding of the nature of emergence, the co-evolution of problems and solutions, and the ability to conduct remote collaborative work, then these must be founded on an understanding of design complexity. Paradoxically, addressing this issue of teaching design complexity may also address some of the wider pressures currently being felt by universities.

While there exists a pressure for design students to be exposed to the complexities of professional practice it is only one of a number of pressures facing universities today. The impact of huge increases in student numbers has been felt by institutions around the world. Design continues to be a popular subject and design departments have seen some of the most significant increases in student numbers. At the same time, those universities offering full-time courses in design are under pressure to further increase efficiency in the use of expensive studio and workshop space. We see greater timetabling and restriction of such resources, an increase in resource sharing such as hot-desking by students and increased use of evening and night time periods. Some institutions have had to juggle increasing student numbers at the same time as experiencing the closure of studio and workshop space. There are also new pressures on staff time - not least those resulting from the opportunities and responsibilities of research activity. There are pressures on staff to assess equitably, fairly and speedily and to adopt teaching methods that demonstrably reflect good practice via the accumulation of portfolios or other bodies of evidence. Many universities offering full-time design degrees have sought to offer undergraduate students a thick or thin sandwich course allowing a long or short work placement. These potentially offer students immense opportunities to engage with the complexity of modern design practice but they are increasingly difficult for universities to offer. Fewer and fewer companies have the time, support staff and funding to

host such placements; only a small proportion of any year group can take advantage of such an opportunity and universities find it difficult and expensive to monitor and assess such placements using skilled and experienced staff. Ideal as it might be, we are not going to see the widespread use of student placements as a means of developing high-level design competences through immersion in the complexity of professional practice. It's clear that for the foreseeable future, universities will have to devise their own systems for exposing students to design complexity.

Students are, understandably, more demanding of the quality of education they receive. There is a greater transparency in institutional procedures, a greater accountability and new empowerment of students as customers. Alongside this there are pressures to equip students with generic and transferable skills, particularly in computing. This has led to a significant increase in the use of information and communication technology (ICT) in undergraduate courses and its influence has been particularly felt in design education. This has not simply been a response to the generic issues identified above. It has allowed universities to mirror some of the developments taking place in professional design practice including the near-universal use of CAD.

The next section discusses the design and delivery of a new part-time, distance undergraduate design course at the Open University (OU). The production process not only reveals complexities that mirror the emerging complexity of professional design practice but some of the tools, techniques and approaches are presented as potentially valuable means for campus-centred universities to assist full-time students to develop skills with and knowledge of complexity in design.

4. COMPLEXITY IN AND THROUGH CURRICULUM DEVELOPMENT

February 2004 saw the launch of a new second level course in the Faculty of Technology at the Open University. *Design and Designing*, coded T211, has a focus in product design but also exploits examples drawn from, for example, fashion, architecture and graphic design. Whilst being founded on earlier successful OU design courses from the past 30 years, T211 is more than an update of its predecessors. It is a new attempt to present part-time design students with relevant experiences of design complexity during home study. The 60 points from this course can be combined with 60 points from a new third level design course to give students a Diploma in Design and Innovation, and they can go on to accumulate 360 points required for an honours degree. The course consists of six blocks, amounting to around 600 hours of part-time study in total. Thus T211 is roughly equivalent to one semester of full-time study, or one sixth of a three-year, full-time degree programme. The author of this paper chairs the Course Team. The annual student population is around 400.

The course team for T211 set the ambitious aim of devising a distance learning course that supported students in learning *through* design as well as *about* design. It sought to develop what Gardner⁶ defined two decades ago as different forms of intelligence, at the same time as being conscious of Friedman's⁷ more recent observation that modern design education demands a balance of critical inquiry and reflective practice if it is to combine knowing and doing. It also sought to strengthen the notion that there are 'principles' of design that can be observed, learnt and applied. Participation in the generation of ideas, the modelling of conjecture, the communication of intention and the evaluation of proposals is a vital strategy for developing an understanding and appreciation of the implicit principles and practices of designing. This sort of support and development will be familiar to those universities and colleges who offer a traditional model of design education via suites of studios, workshops, lecture rooms and display spaces but the aim was an ambitious one in the context of a distance learning provider. Of course, the characteristics of the market for part-time design education had a significant bearing on course design. Typically, Open University students have widely differing profiles in terms of age, experiences and qualifications and they are distributed around the UK and mainland Europe. In addition to the significant demographic differences, mature, part-time design students are rarely looking for design competences in order to practice as professional designers. While many have considerable commercial experience in design-related fields, most do not seek to present themselves as designers. Rather, they wish to further their professional development by acquiring and transferring design skills and knowledge. Of course, others are novices.

The development of the course concept displayed many of the typical characteristics of concept design seen in other design contexts. Partly the process was founded on evaluation of teaching and learning from earlier design courses but the incorporation of creative thinking was vital. Simplified models of the course were generated and discussed. Sometimes these took the form of written notes while at other times they were represented by quick pictorial analogies, for example, a layered cake cut into slices. Such conjecture not only facilitated evaluation by the academic team but it stimulated discussion with other participants in the wider production process. For editors, designers and software writers the sketch representations gave form to conceptions of complex and abstract learning outcomes or relationships between

course content, enabling them to offer relevant expert contributions and critical analysis. This process of sketching out conjecture early in the process was repeated for the concept design of each block within the course. The configuring and development of the material was no less complex including the sourcing and briefing of external authors, and the specifying of audio visual resources for the course DVD. There were numerous examples of iteration from this stage back to the conceptual vision of the course. Partly, these were dictated by practical considerations such as time or financial constraints but partly such iterations were stimulated by opportunistic, creative thinking. For example, a video case study of commercial design practice made quite late in the production process highlighted some emerging new responsibilities for designers today and this required some reworking of an earlier block (and for which it then provided the perfect illustration). The construction of the DVD closely mirrors the design complexity that the course sought to highlight. While the course team specified the content it was not at all clear what the DVD product should look like, partly because this medium is relatively new in distance education. Clearly it had to display high levels of usability - not least because the course was concerned with teaching the importance of usability in design. Specialist staff including the designers of digital resources within the University were able to offer their own conjecture for consideration and each presented new opportunities for addressing the overall aims in new and exiting ways. A key design complexity lesson here is the need for efficient incorporation of relevant emerging information and the filtering out of unwanted or irrelevant information within the limits imposed on the project. Time management was vital. Not only did it ensure that sufficient iterations took place but it raises confidence amongst the wider participants in the production process. When materials are regularly handed over on time, and to a professional level of completion, people are more sympathetic when one needs an extension to a deadline! The course team held regular face-to-face meetings but also circulated draft documents via email. Typically, OU course production requires the generation of a full rough draft (D1), a finished draft with all text and illustrations specified (D2) followed by a 'hand-over' version to the editor. This marks a new stage of iterations where the editor and course team liaise on the detailed issues of consistency, phrasing, presentation etc. Just as practicing designers are called upon to understand an increasing complexity of market legislation, standards, material science or manufacturing systems so the course team were involved in issues ranging from assessment tools to marketing. Even at the concept design stage course descriptions needed to be printed and circulated or put onto the OU's web sites requiring some careful and anticipatory phrasing. Tutors needed to be recruited well before the course was completed and in order to do this a specification needed to be written.

Section 2 outlined complexity in design practice and many of the observations find parallels in the production of T211. Creating *Design and Designing* required a problem to be defined and it was resolved not in a linear way but via a sequence of iterations. These iterations exploited (and in some ways relied upon) the loose modelling of conjecture as a stimulus for the simultaneous operation of two distinct design strategies - one broadly creative and synthetic, the other broadly reactive, reflective or analytical. To achieve the intended outcome certain members of the team, notably those on the academic team and the course manager, required a developed ability to work with uncertainty, to overcome conflict and to work collaboratively. In order to play a central role in the course team it was insufficient to be merely a subject expert. One had to have an ability for immersion in the various priorities arising from the many stakeholders, in this case the students, the tutors, the University as a centre of publication and those involved with the various degree programmes in which T211 would be a permitted component. The course team sought advice on a huge number of subjects such as material science and digital modelling. This generated large amounts of potentially useful content but they had to remain focused on the successful integration of these resources by the diverse student user group. Controlling, storing and providing access to design information has been as significant a job as generating design information. It was noted above that new tools for remote collaborative working are widely exploited in modern design practice but the production of this course also reveals the importance of established practices. Primarily, face-to-face meetings still appear to have great value but this may be because of the ease of calling such meetings. It remains to be seen whether new examples of course production exploiting internationally distributed academics still feel the need to meet physically or whether video conferencing and other systems for sharing and working on outputs can be effective. The importance of private, reflective time for individuals also seems to be vital as teams become larger. This is probably most significant for those coordinating the progression of the project.

The significance of information and communication technology (ICT) in design means that it is both a subject for study and a means for students to participate in the course. It has had a significant influence on teaching, assessment and student learning in T211. All the audio-visual material used to illustrate and support the blocks is contained on a single DVD and the production of this multimedia resource drew on the expertise of a wide variety of staff at the OU. The DVD presents, for example, video sequences of designing activity and interviews with designers and there are video sequences demonstrating sketching and card modelling skills. There are audio tracks presenting course team analysis,

plus galleries of images and case studies. The DVD also contains the necessary software for students to conduct their own investigative and creative activities including a visually stimulating and easy-to-use materials and processes database, and *SolidThinking*, a surface modelling CAD program suited to those students who are using CAD for the first time.

Students of T211 are required to have a computer connected to the internet and some assignments require visits to web sites as part of study or the completion of an assignment. Most universities now have comprehensive networks allowing students to undertake activities from their halls of residence or student homes that once would have required them to visit a department or library or travel off-campus. Email, module conferences and bulletin boards have facilitated sophisticated virtual communities of students even though they may all live and work in close proximity, and this has been exploited to allow new types of collaborative work. Campus universities now frequently combine mechanisms for distance support by tutors with face-to-face meetings. Such initiatives are not new to the Open University which has embraced ICT as a valuable means of supporting distance learners since the 1960s. T211 provides a number of electronic conferences in support of teaching and learning. There is a conference dedicated to the T211 associate lecturers enabling them to raise questions, share good practice and anticipate issues. Another conference is open to all T211 students and staff for course discussion and there is a further 'T211 café' conference for general chat. In addition to these each tutor has a conference dedicated to their own tutor group. Students can post questions and receive a reply from their tutor and, where relevant, from the author of a block or assignment. Students post comments and photographs of work and create virtual learning communities around specific issues. Admittedly, there are concerns regarding the sharing of design proposals prior to individual assessment and this needs to be resolved, but undoubtedly it creates a fertile environment for the development of skills and knowledge including some rich group engagement and occurrences of collaborative working.

But what of the experience of complexity from the students point of view? Did the course manage to make complexity sufficiently transparent for students to develop skills with design complexity? Some aspects were successful. Although T211 is a second level course at the OU, for many students this is their first exposure to the methods and procedures of design. Student feedback from 2004 confirms its success in providing an appropriate introduction to design as *output* and designing as *process*. The teaching of sketching and card modelling exploited video demonstrations. Students appreciated the ability to study and replay sequences and compare their outputs. In some ways it might be seen as superior to teaching drawing as a face-to-face studio group - especially for beginners. One of the main barriers to learning *through* design at home (or while at work) can be the provision of support resources. Realistically, project work is limited by students' access to materials and tools and the appropriate spaces to use them safely. Of course, some students may have very good resources but the experience must be designed for a broad range of students including those studying in unusual circumstances such as those in the military. However, even given these limitations the assignments to date reveal a skilled use of a range of drawings and constructions - particularly to assist usability investigations and the evaluation of concept proposals. The 6 coursework assignments and the end-of-year exam plus formal student feedback reveals an ability to integrate knowledge in their designing, for example, the appropriate use of modelling and partly this has been learnt through the video studies of professional designers and exposure to the analysis of the course team and other experts.

5. LESSONS FROM A MODEL OF DISTANCE DESIGN EDUCATION

As noted above, many OU students view their courses as a part of a broader career development, or enroll out of interest in a subject, rather than as a means of achieving employment in a particular field. However, we are seeing on T211 a significant increase in students aged 18-25 who do view this course as the foundation for a career in design. In 1996/97 12.5% of all new student registrations at the OU were from those aged under 25. By 2003/04 this had grown to 20.1%. The student population on T211 reflects this high proportion of younger students. If this trend were to continue it is predicted that by 2010, students under 25 will account for 27% of new registrations, 11% of continuing registrations and 17% of registrations overall⁸. Why do we see this increase in younger students? Partly, it is the attraction of earning an income in parallel with part-time study. Partly, the costs are significantly lower given that most younger students will be living with a parent or parents. Feedback from university surveys also suggest that younger students do not have the qualifications to enter an increasingly competitive sector of higher education and they are not put off by distance learning and the increasing role of ICT in distance education. Certainly the ability to customize OU degree programmes to suit individual needs is valued by students. Of course, there will always be a significant number of students who have a clear vision of what they want and who will demand an intensive degree course in the shortest time possible but future students in this category will find that even full-time courses increasingly exploit distance learning tools.

Younger students are more likely to view a design course as a preparation for employment and this places demands on the vocational aspects of design curricula. However, it has been clear for at least two decades that there are not sufficient design posts to absorb all the design graduates emerging from the various universities. This is particularly true in product design where manufacturers and consultancies take only a small proportion of graduates each year into traditional design posts. What we have witnessed since the early 1990s is the use of design education - and particularly product design education - to develop in young people, a range of skills and competences which have application across a broad spectrum of business, industry and commerce. Today, universities offering product design education have to confront the dual imperative of providing a vocational training such that graduates can make immediate contributions to an employer, whilst supporting the development of broader transferable skills that widen the employment options of graduates. For both the Open University and the providers of full-time design degree programmes the challenge has become the identification and application of a range of learning tools that address this dual imperative at the same time as exposing students to the issues of design as a cognitively complex and a contextually complex subject. Given the pressures on resources such as staffing and space, and the demands of the student market, it would appear that distance learning tools – and particularly those exploiting ICT – will become the norm in supporting undergraduate design students.

6. CONCLUSIONS

Design education might be viewed as a valuable means of developing a competence with complexity. It certainly seems to lie at the very heart of undergraduate design education today. Designing and design education have always displayed complexity but clearly both are more complex today than even a few decades ago. Students need to know how to access and utilise many types of information, they need to engage in multidisciplinary team working, resolve conflict, generate innovation and management information, people and systems. Not only must students emerge from higher education with a demonstrable competence in dealing with complexity but curriculum design demands that academic staff display a competence for creating appropriate learning environments that illuminate this complexity. In 2001 Nigel Cross⁹ proposed that there was a need for a new model of design education, one suited to a post-industrial design culture. In his paper he suggested that this new model should make design education more accessible, ubiquitous, continuous and explicit. In short it should be more 'open' and T211 has attempted to address this. The course has allowed a wide range of students to develop a sound foundation of *knowing about* design and some valuable participation in the *doing* of designing.

Student markets are changing and the demands of employers are changing. These require an innovative response from universities. Many jobs in business and commerce today require non-design trained employees to apply design or design-related skills such as defining problems, creatively generating ideas, modelling conjecture and communicating. It may be that future design courses pay less attention to the vocational and educational requirements of a shrinking market, consisting of traditional employers of designers, in favour of in-service development of transferable skills and knowledge for a broad and diverse market of employees and employers. There are important messages for universities regarding the use of distance learning methods to effectively support full-time students of design. The development of design skills and knowledge need not be restricted to conventional approaches using studio based project work and face-to-face teaching. Printed materials and digital resources, supplemented by computer mediated communication, can enable students to develop design competences, even where students are located on campus. T211 has successfully used both printed materials and more recent computer based tools of distance education to support, at a distance, the development of knowledge of *concepts* such as conflict, sustainability and markets; knowledge of *associated professional fields* such as ergonomics, engineering and materials science; knowledge of design *practice* such as techniques and processes; and knowledge of design *principles*. At the root of much of this is a competence with complexity.

ICT has been presented as a means of giving students a qualitatively different experience to traditional face-to-face styles of teaching and learning design and it may be the only practical and cost effective way of supporting learning for emerging international student markets. Given that industrial placements are unsustainable, it may also be the only realistic way of exposing students to the complexity of professional design practice today. Learning *through* design activity is understandably more difficult to manage in a distance learning environment because of the variety of students on the course and the variety of the contexts within which they are studying. There are limitations on what can reasonably be expected of a student who is working from home. There are health and safety issues. And there are cost issues if resources are to be sent out to all students. The case for physically gathering together design students, face-to-face, for some aspects of skills teaching and group work participation is strong. Having said this the assessments used in

T211 document a progression of skills and competences developed through part-time distance study including the ability to make design evaluations based on observations of products and processes; the ability to select and apply analytical skills in identifying and interpreting the requirements of potential users of future products; the ability to select and apply creative approaches to various types of design problem, the ability to generate and exploit design models to explore and communicate design; and the ability to transfer principles between design contexts. As well as these subject specific competences students have also demonstrated learning management skills, communication skills and ICT skills.

For all universities there are challenges to reduce costs. Those offering full-time design education are particularly subject to pressures on space and staffing and it seems likely that future design modules will adopt distance learning tools for local and remote study - particularly where these are concerned with the development of knowledge. We are likely to see even more radical innovations in design curricula and any university considering this needs to ask: 'How do practising designers manage complexity and how can this competence be developed in such a way that it is transferable, by graduates, in a wide range of contexts?' This paper suggests that this can partly be addressed through the creation of appropriate distance learning environments.

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