Bringing Human Computer Interaction into a Department of Product and Systems Design

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Abstract: This paper describes setting up a curriculum for a new university department of Product and Systems Design. As a result of the activities undertaken, it was noted that there was a surprising lack of Human Computer Interaction (HCI) oriented courses on offer in Design departments. This lack is despite the fact that the HCI literature shows an ever-increasing concern with design of artefacts. Also, design educators frequently refer to the need for more training in user-centred design in order for both students and practising designers to be able to create products and systems for the information age. In the new world of digital as well as tangible objects, of virtual products and services, the theme of usability and accessibility that are central to HCI offer a rich pool of knowledge. This paper explores some of the HCI topics that can be of use to design students and describes how they are to be incorporated into the curriculum of the Department of Product and Systems Design.

Keywords: Design Education, HCI topics

1 Introduction

This paper discusses the experience of a new university department in developing its curriculum to include education on topics directly related to the information society. In this changing society globalisation and the trends in communication technologies are impacting the ways in which people and organisations think and act. The products and systems that designers need to help create will belong to this changing world. For designers of products and systems, this means adopting new perspectives, and understanding that many future activities and tasks will be virtual and many objects will be digital, comprehended only through a mental model or some kind of metaphor.

The inter-dependence of these perspectives and the need for users of products and systems to understand and make use of technology will be a fundamental part of any future design brief. With the 'growing use of embedded computing systems in all kinds of devices' (Gorny & Hewett, 1997) the study of topics in the HCI curriculum would seem a very useful part of design education. However, this does not seem to have been recognised in many departments around the world where design is taught and studied. Similarly, many members of the HCI community do not seem to realise that effectively they are engaged in product design and should be integrating their work with that of the design community.

A review of the curricula of Design Schools and university departments world wide, as well as the literature on design education, reveals some understanding of the importance of user-centred design and usability of digital artefacts in the design of products and systems for the 'information age' (Boyarski, 1998). While this may not be true of all types of design subcategories (e.g., architectural, engineering, graphic and interior design) it is typically true for industrial and product designers, reflecting a long standing concern with designing for the user (Dreyfuss, 1955). However, few of the design curricula examined specifically mentioned topics in the HCI curriculum, such as interface design, task analysis, interaction design, human social organisation and work, which seen from the HCI perspective, to offer much that is useful to the future product and systems designer.

One might be tempted to argue that the lack of HCI in design schools is attributable to design not necessarily producing computer-related artefacts. However, the fact that some schools of design are now offering courses relating to artefacts that are essentially digital, such as BA in Multimedia Design (De Monfort, UK, Northumbria, UK), Interactive Multimedia (Staffordshire, UK), Bachelor of Design Computing (University of Sydney), suggests this argument is not tenable. Nor can it be claimed that designers are simply not aware of HCI. In their newsletters, and online forums and discussion groups, they often publicise HCI related events. As was shown by the survey, some of the most well-established design schools do include HCI courses in their curriculum, but this does not seem to have influenced other schools.

Yet, even if HCI does not at present routinely feature in design departments' undergraduate curricula, design educators recognize that there is a climate of changing professional needs of graduating industrial designers (McDonagh Philp & Lebbon, 2000). They note that students (and indeed practising designers) need to enhance their knowledge of user-centred design, stressing that: "The development of a robust product specification is dependent upon accurate information about the lifestyle, needs and aspirations of the target user or buyer, as well as the functional constraints of manufacture." (Torrens, 2000)

This paper argues that the time is right for design departments to allocate some space to the teaching of HCI and for people with HCI expertise to begin working with and in design departments. Typically design is taught as a multi-disciplinary profession and students are confronted with a combination of design issues, technology skills and information to assimilate into their design activities (McDonagh-Philp & Lebbon, 2000). At the same time, the field of HCI increasingly concerns itself with design, (Fields & Wright, 2000) and particularly with designs of systems that feature technologies. Furthermore, the HCI community has of itself also suggested that HCI education could be integrated into the curricula of disciplines such as Design (Gorny & Hewett, 1997; Hewett et al., 1992)

In the next section, the genesis of the department of Product and Systems Design of the University of the Aegean is briefly described, thereby giving the context for the review of the curricula of design schools and for the convening of a workshop on an undergraduate design curriculum. Findings of the survey, as they relate to the current place of HCI within the various programs, are presented and discussed, as are the outcome of the workshop held to structure guidelines for the curriculum to be instantiated in the department of Product and Systems Design.

2 Genesis of the Department of Product and Systems Design

The state funded University of the Aegean was founded in 1983, and is one of the largest of the newer Greek universities, being composed of seventeen departments. As part of its mission, the University seeks to move into newer areas of teaching and research, offering subjects that are rarely to be found elsewhere in Greece. The goal is to produce qualified graduates for employment sectors that could not be filled easily because the necessary education was not available in Greece, thereby forcing those who wanted to work in such areas to go abroad to complete their education.

The new department of Product and Systems Design is planned to eventually be part of a complete School of Design. This first founding department concentrates on the design of user centred products and systems in innovative technologies. This meets the University's conditions for being both forward looking and applied. Also, design constitutes an area of study, which is not being taught in Greece in any unified way at the university level by state funded institutions. It is also a subject that is becoming increasingly important in both the sciences and the arts world-wide (Kaufman, 1999).

In order to help define the knowledge sets required by the graduates, two foundation activities were carried out. The first was a world-wide review of all state funded university design departments, where information was available. The second activity was convening a workshop to which several leading figures in design education, curriculum development and representatives from local industry were invited.

2.1 A Review of Design Curricula

As a basis for identifying the foundation structure of design curricula, a review of design schools and departments was carried out using web sites, and/or contacting schools directly for more information about their curriculum. In total, over 150 schools and programs throughout the world were examined. The countries involved included the United States, Canada, the UK, Australia, Japan, Hong Kong, France, Germany, Sweden, Finland, the Netherlands, Italy, Mexico, Turkey Brazil and Colombia. Several schools were not included in the final comparison

because they did not conform to certain basic requirements.

Firstly, the schools and/or departments had to be university level institutions offering an accredited undergraduate Bachelor's degree. Design is a difficult subject to categorise because of its roots in crafts and guilds. In many cases, there is a blurring between craft schools, where the emphasis is on making and techniques for making, rather than on theory of design. Craft based design schools are often more comfortable when they describe their activity in terms of the materials with which the students study and create, e.g. wood, pottery, jewellery, furniture. Generally speaking, this is more often the case for the design schools of Europe. In the United States, Canada, and Australia, there is a more of a clear-cut division between the activity of making, and the study of design as an academic subject.

Secondly, the review included only schools where funding is provided by the state rather than private sources. Although in some cases, with degrees being offered on a franchising basis from a state funded university, this requirement was sometimes a bit blurred. The focus on state funded institutions was dictated by a concern with seeking comparability of institutions on this rather significant dimension and the other dimensions which are impacted by this critical variable, e.g., infrastructure. The nature of the education offered as well as the infrastructure under which the institution is operating had to be comparable, before a department was included in the final review.

Of particular interest was identifying departments teaching design as a discipline. In addition there was a particular interest in identifying forward-looking departments, e.g., those engaged in creating products and systems for the 'information age.' Consequently, departments of design where smart appliances, and innovative technologies were part of the design project work, were given closer attention than those whose design briefs are in specific 'tangible object' areas, e.g. furniture making.

The survey yielded some results that were surprising to those who had, as a result of their HCI teaching and practice, expected to find HCI prominent in design education. Of the 150+ programs identified and reviewed, only 65 provided enough information on their curriculum to be able to ascertain the presence or absence of HCI type topics. Of these 65, only 11 offered any related subjects at undergraduate level, although more than twice that number offered graduate degrees in some form of interaction design. While it is possible that HCI topics at the undergraduate level went under other names or labels, or were part of special topics seminars, this could not be inferred from available material. What was surprising here was that in an era of growing recognition of the importance of digital artefacts, there seemed to be so little about design of such artefacts being offered to undergraduate students.

Where there was an understanding of HCI issues it was at those schools which are known to be forward looking and innovative. A sample of these are described below, this list is not intended to be exhaustive, but rather, give the 'flavour' of how forward looking design departments include HCI or User Centred Design (UCD).

Of the 'HCI aware' schools, Carnegie Mellon University (CMU) in the United States is the most prominent. But this is not surprising given that CMU's Department of Design planned a Masters in HCI in 1994. And even before that, in 1989, it pioneered an undergraduate course in HCI, which besides being the only HCI course at CMU, was housed in the Design Department.

Presently at CMU there are two courses taught at the undergraduate level, which for illustrative purposes are described in more detail. Both courses are called "How People Work" and are taught in the 2nd and 3rd years of a four-year course of study for students in Industrial Design. The first course is an introduction to the general field of applied human factors. It centres on anthropometry, perception and simple human–machine interaction, while providing the student with an introduction to the practice and roots of the human factors profession. The second course assumes literacy in the basic practices of system analysis and data application. It focuses on methods for collecting and analysing information pertaining to design for complex human-machine interaction. "Particular attention is placed on the understanding of the end users current needs and trends that will affect future needs. The primary goal is the translation of that goal into design criteria (specifications) that will be useful during the formative stages of product development."

Some other schools, such as at the Universities of Loughborough and Staffordshire in the UK, have integrated human computer interaction into their undergraduate curricula. At Loughborough, this integration relies heavily on arranging for design students to meet with end users and discuss requirements intensively and systematically, rather than assume user characteristics. At Staffordshire a Human Factors module is offered in the second year of a three-year course. In this module, Action

Research methods are taught to students, and put into practice in their interaction with a group of users.

Another small set of schools rely on a multi-department approach to product design education. For instance, Product Design Engineering, leading to a BEng degree, is a course run jointly by Glasgow School of Art and the University of Glasgow. It claims a 'human centred engineering design approach' as one of its distinctive features. At the Delft University of Technology, in the Netherlands, the School of Industrial Design is organised into four departments, those of aesthetics, engineering, ergonomics and new product development, and each teach courses to the students.

There are, of course, other design schools and departments that offer human factors and ergonomics as part of their undergraduate course such as Umea in Sweden or Savannah in the United States. Sometimes these topics are optional. Sometimes they are compulsory. Another approach is to integrate some techniques into the fourth (final) year group project work as is being done at Carleton in Canada (Frankel, 2000). However, most often, human factors and ergonomics seem to be treated as peripheral subjects, and are not obviously well integrated into the degree course.

2.2 The Curriculum Workshop

Another activity preparatory to setting up the University of the Aegean's new department of Product and Systems design was that of holding a curriculum workshop. The title of the workshop was *Profile and Curriculum Content of University level studies in Product and Systems Design.* The 2-day workshop began with a series of presentation made by representatives of local industry to provide a business context for the discussions to follow. During the mixture of presentations, discussions, brainstorming and reflection sessions, leading design educators (primarily from the UK, The Netherlands, and Germany) were invited to give their views on international 'best practice' in the area of Design Education and Research. Written contributions from design educators in the United States, Australia, and Italy and Norway were also available. Interestingly, although HCI was not mentioned by name, all participants advocated that a policy of user-centred design be deeply embedded in the new curriculum. In addition to reflecting the practical experience of the assembled educators, this level of agreement may also reflect the fact that product design has a long history of having major practitioners emphasise the importance of user centred design (e.g., Dreyfuss, 1955).

In a full day interactive session, 'facilitated brainstorming' was used in order to identify and define areas of knowledge that students should have upon completion of their course of study. Workshop invitees unanimously advocated the teaching of 'systems thinking.' This term was meant in its widest sense, as an understanding of the context in which a future product or system was going to function, and not merely as the understanding of a technical system. The curricular 'wish list' developed by workshop participants had over 80 knowledge modules. Some were distinct topics and some, which were subcategories of others. Elements were grouped together as either 'core topics' for design or under the temporary title of 'collateral topics.' It was the collateral topics where those that are most closely related to topics found in an HCI curriculum tended to be grouped. Amongst the 'wish list' of collateral topics were:

- Sociology-cultural and social factors
- Psychology – human to human interaction
- Human Factors and Ergonomics
- Cognitive Engineering and Ergonomics
- Physical Ergonomics,

Ten days after the workshop, participants were asked to review the complete topic list and give their opinion as to which ones should be taught and at what point in the curriculum. Participants were also invited to revise the groupings if they wished. Two participants each reclassified the 80+ elements, putting them under 4 headings. The HCI type elements bulleted above were listed under the heading 'Systems Thinking and Systems Concepts' by one participant, and under the heading 'Human/Economic Context' by the other. A third participant specifically requested that 'Systems Thinking and Systems Concepts' be given a more prominent place, suggesting that it come immediately after the topics grouped as 'Theory and Methods of Design'. Interestingly, he also suggested that the HCI elements form part of the Theory and Methods of Design, a fairly stable group of topics viewed by all participants as forming the core of Design subject matter, including History of Design and Concepts and Principles of Design.

Another set of topics, grouped under the title of 'Problem Framing,' were considered by the participants, in their ranking and re-organisation of the wish list, as either:

- Only to be considered in the context of an actual design project (1 participant);
- As part of Systems Thinking and Systems Concepts (1 participant);

- As on a par with a consideration of Ethics and Environmental studies (1 participant);
- As part of Creative Thinking (1 participant).

Finally, it is worth noting that all workshop participants, without actually mentioning HCI per se, subscribed heavily to the idea that some of those elements that are also fundamental to HCI theory and methods be included in the curriculum.

3 Integrating HCI into the Curriculum of Product and Systems Design

After having looked to see how HCI was taught in design departments, and having consulted with experts both in education and practice, the conclusion that HCI should be integrated into the Product and Systems Design Department was clear. What was not clear was how and where.

Extrapolating from the many definitions of HCI, and even more of design and designing, it seems that HCI is typically concerned with computing devices and/or digital artefacts, and on simplifying the complexity of the cognitive load. On the other hand, design is typically concerned with an aesthetic dimension that is not present in HCI; with the physical interaction with the product; with materials and production processes. Yet, the rest of the semantic fields of such definitions tend to share the same or similar bodies of knowledge and activities. The recommendation that an HCI specialist needs to be "equally comfortable dealing with technological issues, the needs of individuals and the concerns of their organizations or work groups." (Hewett et al., 1992) is clearly relevant and applicable for artefact designers in the information age. Similarly, a concern with some of the values and methods stressed in traditional design education such as visual communication skills, idea generation and understanding of the business of product design, could also have value for HCI.

It needs also to be borne in mind that HCI is itself evolving. For instance, there is more than 'traditional HCI' in the form of task analysis and cognitive modelling, especially where these are focused on the individual and their interaction with a single computer system. Work on Computer Supported Collaborative Work (CSCW) concerns itself both with the interaction of individuals with one another, and with the context or 'setting' of the interaction. Some HCI work borrows from social science methods of studying work practices and designing technology, where the meanings of artefacts are negotiated through practice. Furthermore, HCI researchers have begun to concern themselves with the often subtle way that work practice is shaped by technology and technology by work practice.

Thus to answer the question, "What can HCI courses offer the design undergraduate?" is to point to bodies of knowledge that can be grouped under the three headings of technology oriented, user oriented and context oriented. Similarly, to answer the question, "What can design courses offer the HCI undergraduate? is to point to bodies of knowledge and techniques which can impact the HCI undergraduate. In this paper, there has been more emphasis on answering the first question. However, the following bullets summarise the main conclusions of the teaching and research staff of the department, whose backgrounds and experience are in Engineering, Mathematics, Physics, Design, Architecture, Art, Operations Research, Systems Thinking and, of course, HCI.

Technology oriented

- Basic computer technology, including hardware, software, networks, and systems
- Basic principles of visual, auditory and tactile displays
- Some basic modeling languages; for rapid prototyping, etc.

User Oriented

- Knowledge about the information processing abilities of the human
- Task Analysis
- Various means of assessing / predicting / addressing usability e.g**.** usability walkthroughs; predicting usability via human performance models; design rationale; questionnaires; etc.

Context oriented

- Methods and frameworks for the study of workplace and work activity: this can provide insight into not only what problem is that needs to be solved, but what can be most appropriate given the way the work is carried out currently. Some of this can be seen in process re-engineering, contextualising design and ethnography studies. All these are approaches to discovery, to identifying use, values, needs, and to assessing usability 'in the field' work (or play) context.
- User Centred Design Methods for requirements capture, problem framing and

evaluation: a range of methods and techniques can be introduced to students so that they can choose which one suits them and the situation best for their particular design brief. From Action Research to Soft Systems to Participatory Design where users are involved 'codesigners/ coanalysts' rather than solely as subjects of study or providers of feedback

Other useful subjects that overlap all three categories are Guidelines and Standards, where both the nature of standards and guidelines, and ways to incorporate them into design are areas to be taught and studied.

At the same time, as has been noted, there are subjects in the Design curriculum that are of immense usefulness to the HCI community, which has been observing and adopting some of these more intuitive techniques and trying to systematise and codify them for a number of years. These are techniques such as:

- Prototyping and User Testing via observation/measurement of user interaction with the artefact, creating possibilities to be seen/touched; soliciting user feedback; focus groups; and examination of strengths and weaknesses of common approaches
- Creativity development through moving from an understanding of what is to what might be, e.g., the roles of metaphor, role-playing, stories, low-fidelity prototyping, etc. in design.

The most viable way of incorporating these important subjects into the design curriculum in the Department of Product and Systems Design has been to include them as topics in different courses. The degree course is for five years, but from the first year students are introduced to the concepts of HCI. Some of this introduction takes place in an Informatics course that introduces students to concepts from computing systems and information systems, i.e. the technology aspects. Other HCI concepts and practices are part of the Design Theory and Methods course i.e. the human and contextual aspects. This material takes the form of 'traditional' HCI in such subjects as task analysis and human information processing, as well as in exploring some of the methodologies and approaches for knowledge acquisition and for gathering user requirements. The goal of introducing HCI units into various modules of the five-year course is to place them where they will be of most relevance to students. The timing of HCI topics is planned to coincide when similar concepts are being discussed in studio and group project work that also starts from the first year.

Following the recommendations noted by Sears (Sears, 1997), each time the literature refers to people, users, or computing systems, students are encouraged to take this in the most modern and futuristic context. For example, 'people' can be one user interacting with a system, or a group interacting using a system as a medium. Users can be expanded to include a range of individuals with particular skills and limitations. 'Computing system' means much more than the traditional computers as PCs and can include all sorts of devices with embedded CPUs, such as smart appliances or wearable computing. Similarly 'interaction' can be between one or more people interacting with ATMs, information kiosks, medical equipment, telephones, aeroplane cockpits, stereos, fax machines, etc, or in networks of all sorts supporting various types of online communities (Preece, 2000a, 2000b).

4 Concluding Remarks

Design graduates are trained to develop their creative and visualisation talents and skills, to communicate effectively, and to understand key components of the world they are designing for, in order to become valued members of the collaborative teams that are today the designers of new products. At the same time, as part of an interdisciplinary team they will need to interact with team members from different backgrounds. Their knowledge of HCI related subjects is not supposed to make them computer experts, nor experts in ergonomics. Rather, the intention is that exposure to these knowledge sets and skills will make them aware of some of the issues. It will also point them to explicit developing bodies of knowledge where they can look for guidance (e.g., standards in ergonomics, or some cognitive guidelines) and will give them a range of requirements capture and evaluation methodologies and techniques, so essential to user centred design.

The climate of design education, as well as that of design practice, is ripe for the introduction of HCI oriented courses. The demands of the information society, where knowledge and data have become commodities and where a plethora of new devices enable networking and interacting, rely more than ever on the usability, reliability and attractiveness of these devices in order to increase the efficiency of computer mediated work and communication. The field of human-computer interaction offers a rich and pertinent resource for those whose future activity will be with designing such devices and the systems

that support them, and as such it should not be ignored. The merging of the Design and HCI communities, already often a fact within professional practice, could be strengthened were the merge to take place within undergraduate education. There are mutual benefits to be gained on both sides. Not the least for HCI is to be associated with departments and disciplines other than those of Computer Science and Psychology (Gregor et al, 1998).

Introduction of HCI into the undergraduate design curriculum at an early stage will establish firmly the centrality of an HCI orientation in design education for the information age. However, given the rapidity of technological change it is also necessary to begin to think in terms of new types of educational structures, particularly those embodied by 'life long learning', where learning does not end with the acquisition of a degree. The knowledge of HCI theories and methods students gain during their undergraduate studies can be revisited and deepened in subsequent learning cycles as required. The department of Product and Systems Design is fortunate in that it has started from a 'clean slate' and with a strong interdisciplinary background that permits the establishment of such a curriculum. It is hoped that the experience of implementation of the curriculum should lead both to iterative improvement of the curriculum as well as to identification of core elements of design education which could be integrated into HCI education.

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