HCI curricula in the Faculty of Computer Science and Engineering at Castilla-La Mancha University (Spain): overview and new proposal

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ABSTRACT

Since 1997 the CHICO research Group has been one of the main promoters of HCI at the Castilla-La Mancha University (UCLM) and in Spain. This Group is leading the research and teaching of HCI in the Faculty of Computer Science and Engineering (ESI in the Spanish acronym) at this University. Now, with the aim of defining the academic offer adapting it to the European Higher Education Area (EHEA in the Bologna process) and defining the new study plans (curriculum and syllabus design), we propose several changes in the Interactive Technologies profile given in the ESI. These changes should affect the courses of graduate and postgraduate degrees, and the research associated with the development of doctoral dissertations (PhD). This paper presents the previous situation and the changes proposed to consolidate the HCI curriculum for the professionals of Computer Science and Engineering.

Categories and Subject Descriptors

H.1.2 [**User/Machine Systems**], H.5 [**Information Interfaces and Presentation**]

Keywords

HCI curricula, Computer Science and Engineering, EHEA

1. Introduction

The Spanish universities have begun a phase of major changes to adapt their studies to the model defined in the Bologna process (also known as the European Higher Education Area or EHEA). In this direction, the Spanish Ministry of Education and Science has published a Royal Decree establishing the organization of university studies as follows: engineering o graduate degree, master or postgraduate degree, and doctorate (PhD) [1]. Focusing on the studies of Computer Science and Engineering, the graduate degree is divided into four academic years (8 semesters) and the postgraduate degree is divided into two years (4 semesters). The postgraduate degree can have a professional profile oriented to the achievement of skills associated with professional duties or can have a research profile. In the latter case, the postgraduate is the early stage to the development of the doctoral thesis that leads to obtaining the PhD.

In this situation, a reflection on the HCI curriculum in Computer Science and Engineering is required. Therefore, the recommendations of international associations such as SigCHI Curricula ACM [2] or the Computing Curricula of ACM and IEEE [3] are fundamental references.

Also, the Spanish Association of HCI (AIPO[1] in Spanish) considered this challenge and made a first comparative study between universities representative of the USA [4], Latin America [5, 6], Europe [7] and Spain. This study was developed at the first workshop of HCI teaching (CHIJOTE[2] in the Spanish acronym) [8]. Previously, other studies had been carried out and discussed in very specific events of the International Federation for Information Processing (IFIP). Some results of these studies can be found in [9-11]. In March 2006 another important and similar experience was carried out in Limerick (Ireland). It was the first HCI Educators' Workshop [12] organized by the Technical Committee on Human Computer Interaction of IFIP, the British HCI Group, the CONVIVIO Network (the European network for Human-Centered Design of Interactive Technologies) and the Irish Computer Society. We also emphasize the last study using as a reference the Spanish-speaking countries [13].

This work aims to contextualize the position of the Computer-Human Interaction and Collaboration Group (CHICO research Group) on a profile of subjects taught in the Faculty of Computer

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[1] http://www.aipo.es/

[2] http://chico2.inf-cr.uclm.es/chijote2005/

Science and Engineering at Castilla-La Mancha University (UCLM). Our objective is to establish a reference point in order to reflect and discuss about the organization of the HCI contents in the new curriculum of Computer Science and Engineering in the general context of the Spanish university and especially at the UCLM.

Next, we give a brief description of the recommendations of ACM and IEEE regarding HCI curriculum. Then, the current Interactive Technology Profile of the ESI is presented and we give some details of the progress in the number of students enrolled and its output to the professional life during the ten years of the existence of this profile. Then, we describe our proposal of subjects based on previous experience, on the recommendations of international associations and on the new organization of university studies in Spain. Finally, we point out some concluding remarks and lessons learned.

2. ACM and IEEE recommendations for HCI in Computer Science

Figure 1 shows the HCI items to be covered in Information Technology Engineering according with the SigCHI Computing Curricula [2]. There are several sections or epigraphs which we highlight: basic foundations of HCI, human factors, computer systems architectures (devices and interfaces), development process and HCI projects.

Figure 1. HCI body of knowledge in Information Technology from SigCHI.

According with the Computing Curricula of ACM and IEEE [3], there is a basic body of knowledge of HCI (organized as HC) and other additional items that spread to other sections (see Figure 2). For example, the Net-Centric Computing (NC) section contains items related to the building of web applications and the processing of multimedia information. More significant is the case of items related to hypermedia that are part of the

Information Management (IM) section and the virtual reality items that are contained within Graphics and Visual Computing (GV) section.

In the specific case of the ACM and IEEE guidelines, we must consider their new reports from 2005 [14]. These recommendations emphasize the specialization of the profiles of computer science engineers. However, the reality of the business world in Spain does not demand engineers with such a specific curriculum. This idea also appears in the White Paper of Computer Studies in Spain [15]. Even so, and as an example, the presence of HCI contents in the Software Engineering 2004 (SE2004) [16] and in the Information Technology 2005 (IT2005) [17] is remarkable. In the SE2004, the HCI contents mainly appear as Human Computer Interface Design within the Software Design section and as Human Computer User Interface Testing and Evaluation within the Software Verification and Validation section. With these contents, fundamental aspects of HCI are covered, with an emphasis focused on issues of user interface design and usability engineering. In the IT2005, the basic contents of HCI are organized in a specific section but also other advanced courses are proposed in order to reinforce aspects related to the development of user interfaces, multimedia systems and computer-supported cooperative work.

Figure 2. Computer Science body of knowledge from ACM and CS-IEEE.

3. The current situation of HCI in the Faculty of Computer Science and Engineering at UCLM

Currently, the subjects of HCI in the ESI only appear in the profile of Interactive Technologies, which is a second course of Computer Science and Engineering (comprising the fourth and fifth years). The goal of this profile is to train engineers in Computer Science specialized in the use and integration of the

technologies that facilitate interaction and communication between people and information technologies. The profile includes the subjects presented in Table 1. It displays the elective or compulsory type of these subjects, the semester in which they are given, and their number of credits where a credit is equivalent to ten hours of lessons (lectures, problem solving and practical work in the laboratory). Thus, the credit is used as the unit of measurement for defining the duration of the subjects and the time that the lecturer employs in their teaching. However, this measurement does not consider the student's work.

Table 1. Subjects of the Interactive Technologies at UCLM.

Type	Subject	Semester	Credits
Compulsory	Human-Computer Interaction Systems (HCIS)	7	9 (90 hrs.)
Elective	Multimedia Data Processing (MDP)	9	4.5 (45 hrs.)
Elective	Learning Systems (LS)	9	4.5 (45 hrs.)
Elective	User Interfaces (UI)	9	4.5 (45 hrs.)
Elective	Multimedia, Hypermedia and Virtual Reality (MHVR)	10	4.5 (45 hrs.)
Elective	Collaborative Systems (CS)	10	4.5 (45 hrs.)
Elective	Speech Technology (ST)	10	4.5 (45 hrs.)

In the profile there is a compulsory core subject with nine credits that introduces and presents the basic and fundamental concepts of HCI. This subject is given in the fourth year (seventh semester). The name of this subject is *Human-Computer Interaction Systems* (HCIS) and it is taken by all the students in Computer Science and Engineering degree. Of its nine credits, six are for theoretical contents and three for practical work. This subject is complemented with other six elective subjects having a theoretical content of 3 credits and practical work of 1.5 credits. On several occasions the faculty member responsible for every subject has been asked to extend these subjects to six credits, which is the number of credits of the elective subjects in the first cycle. So far, this transformation has not been possible. The elective subjects are taught in the fifth year (in the ninth and tenth semester). The contents of all these subjects can be found on the website of the Faculty of Computer Science and Engineering[3].

In the subject of HCIS general aspects such as devices for HCI, interaction paradigms (direct manipulation, ubiquitous computing, virtual and augmented reality), the design of user interfaces, aspects of usability, collaborative work, evaluation of user interfaces, etc. are studied. These are a wide range of concepts that will be dealt with later in depth in the elective subjects of the profile, although it is unfeasible to study some of these concepts in sufficient detail. This approach is a direct result of the work carried out by researches, lecturers, trainers and professionals of the HCI area at the Spanish universities under the coordination of the Spanish association of HCI [18].

We highlight that the profile contains some subjects that do not fit into the HCI curriculum. Thus, we consider that the contents of the *Learning Systems* (LS) subject have a minimal connection with this profile. Therefore, this subject should be considered as elective out of this profile. The *Speech Technology* (ST) subject should take a more general approach and address contents of physical devices to HCI. We believe that interfaces with speech technology are integrated within the profile, but we consider that

their contents are tangential to the profile of Interactive Technologies or, in any case, too specialized. However, some of the decisions about the inclusion of these subjects come from the need for balance between staff and organization of the academic departments of the university.

Table 2. Relationship between current subjects of HCI at UCLM and the recommendations of international associations

Subject	ACM/IEEE	SigCHI
Human-Computer Interaction Systems (HCIS)	HC1, HC4	C1, C2, C3
Multimedia Data Processing (MDP)	HC7, NC7, NC8	U2, C5, D2
Learning Systems (LS)	*Non specific in HCI*	*Non specific in HCI*
User Interfaces (UI)	HC2, HC5, HC6, SE2	C2, C5, D2, D3
Multimedia, Hypermedia and Virtual Reality (MHVR)	HC7, IM12, IM13, NC5, NC7, NC8, GV10	U2, C4, C5, D1, D2
Collaborative Systems (CS)	HC2, HC4, NC4, NC9	U1, U2, U3
Speech Technology (ST)	HC7 *(partially)*	C1, *(partially)*

Table 2 shows the subject contents of the current profile at the Faculty of Computer Science and Engineering at UCLM according with the ACM/IEEE and SigCHI recommendations. It can be observed that LS and ST subjects practically do not deal with HCI contents. Also, we can observe that the contents of the MHVR subject are too wide.

3.1 Methodological aspects

The teaching methodology has been applied for all elective subjects, based on the paradigm of face-to-face teaching in the classroom. A first stage would take advantage of the transfer of knowledge through the exposure to content and the evaluation of knowledge and skills through specific exercises and exams. In this first stage, mainly, the following activities were carried out:

- Lessons in the classroom.
- Allocation and monitoring of theoretical and practical projects inspired in principles of learning by problem solving.
- Presentation and discussion by the students of the project and problem results carried out.
- Exams of the theoretical contents and of the practical skills.

A second stage began three academic years ago. This stage was directed to perform experiments with methodologies promoting problem-solving and project-based learning. Moreover, we try to further assess the student's effort, teamwork and the skills acquired. All this is aimed to adapt to the European Higher Education Area and the teaching methodologies emerging from it. Basically, we promote learning based on projects to be developed in group. These projects, in some cases, receive feedback from skills acquired in other subjects. Thus, the practical project to be developed begins with the first subjects of the profile and ends when all subjects of the profile are passed. With this approach, students address the design and development of components of an interactive system linking phases of interaction design, navigation, presentation, development of the user interface, and so on, all of this applied to a case study which should be solved in a working group. In each subject of the profile, we study how the techniques, procedures, methods, tools and specific technologies related to the topics of the subject can be applied to the practical project. This method was first applied to the elective subjects and currently it is implemented in all the subjects of the profile.

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[3]

http://www.uclm.es/ori/english/CR/ESIInformatica/EN_Ingenie roSInformaticaCR.pdf

3.2 The Interactive Technologies profile and the international recommendations

The body of subjects of the Interactive Technologies profile corresponds with the SigCHI Computing Curricula epigraphs (see Figure 1) N1, U1, U2, U3 (partially), H1, H2, H3 (partially), C1, C2 (partially), and C3. C4 is given in an elective subject at the first cycle (semesters 5 and 6). The type D contents are partially addressed but in sufficient detail. The students who develop their final project in the context of the profile achieve the type P objectives. According to the Computing Curricula of ACM and IEEE (see figure 2), these subjects relate to the epigraphs HC1, HC2, and very partially to HC3. HC4, HC5, HC6, HC7 and HC8 are addressed in depth. GV10, SE2 and SE3 are developed in a superficial way and IM12, IM13, NC7 and NC8 are addressed in depth. The NC5 contents are completed in other specific courses taught out of the profile by members of the CHICO Group. The contents of the NC9 epigraph are scarcely addressed. However, these are subjects of special interest in research and, therefore, they are addressed in the doctoral program and in certain specific work of research.

3.3 Results

In this section, we present an overview of the evolution of the students in the subjects of the profile, and how they have passed the tests established to evaluate the knowledge and the skills acquired. In addition, we present some data and interpretations on the demands of the industrial sector with respect to these students.

Table 3. Students enrolled in the subjects of the Interactive Technologies profile at UCLM.

	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
HCIS	70	58	58	85	74	67	58
MDP	14	12	25	16	24	37	11
LS	24	20	16	47	43	34	23
UI	13	27	32	48	52	76	64
MHVR	26	49	36	48	54	54	68
CS	20	12	16	15	27	26	26
ST	10	18	20	30	30	27	30

We have to remember that HCIS is a compulsory subject. That is, to get the graduate degree in Computer Science and Engineering the student must pass this subject. This provides a reference about the maximum number of students who can enroll in the rest of elective subjects. Also, there is a fact evident in recent years. There is a general decrease in the number of students. Table 3 shows the evolution of the number of students enrolled in each subject in the Interactive Technologies profile. In an initial assessment, it can be seen that the number of students who enroll in HCIS has fallen slightly from the year 2004-2005. However, reviewing the data of the current year (60 students enrolled in HCIS in 2007/2008), we think that this trend has stabilized.

Regarding enrollment in elective subjects, it should be noted that students are not required to enroll in all the subjects of a profile. Also, students studying other profiles can enroll in elective subjects of this profile. The graph of Figure 3 shows the evolution of the enrollment. A slight decline can be seen reflected in the HCIS subject (the line with diamond-type points). Focusing on the mean enrollment in elective subjects of the profile (the line with square-type points in Figure 3), we can see that it is rather below the line corresponding to HCIS. Also, it is evident that the subjects of MHVR and UI are clearly the most demanded by the students. If the evolution of students (mean) enrolled in MHVR and UI is graphically shown (the line with triangle-type points in

Figure 3), we can see that the trend is clearly growing, even in recent years. So we can say that almost all students enrolled in HCIS they will be enrolled in these two subjects (MHVR and UI) next year. Currently, the number of students enrolled in MHVR and UI is more than double that of any other elective subject of the profile. This is a consequence that these subjects are chosen by students of other profiles. Moreover, almost all the students of Computer Science and Engineering chose these two subjects. Also, we believe that these are the subjects which best characterize the Interactive Technologies profile and best train students for joining professional life as Computer Engineering Engineers specialized in HCI.
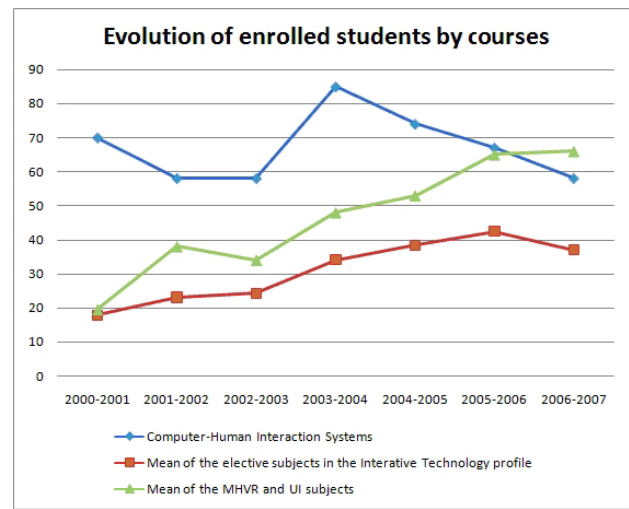
Figure 3. Evolution of students in the subject of Interactive Technologies at UCLM.

About the achieved goals in knowledge and skills, the percentage of students passing the subjects in less than two years is slightly above 90%. If this interval is extended to three academic years, the previous percentage goes up to 100% of the students enrolled.

Analyzing in cursory way the data that we have over job offers from business and industry, we can see that a high percentage of students become engaged in practical activities when they are studying subjects of the fourth year (seventh and eighth semester), and many of them join to the staff when they are in the fifth year (ninth and tenth semester). Most of these students get to work on projects related to web applications, and many of them are involved in the design of user interfaces, multimedia and hypermedia. All these projects are in the context of this profile. Thus, the request for Computer Science Engineers with HCI knowledge in the region of Castilla-La Mancha is justified. In addition, this request has some correspondence with the elective subjects containing more enrollments.

4. New proposal of HCI curricula

We believe our current HCI profile is slightly unstructured. This is a consequence of the subjects that are slightly tangential and not fit into the profile. Also, we believe that for this reason the mean of students enrolled in the elective subjects is well under the number of students enrolled in compulsory subjects. We draw this conclusion from the data described in sections 3.2 and 3.3. This conclusion and the necessary adaptation to the European Higher

Education Area are the main reasons for offering a new proposal of the HCI profile in Computer Science and Engineering.

In this section, we present our proposal to solve the aforementioned problem, adapting the profile to international recommendations, stating it in the regulation of new university studies and consistent with the context of the industrial society of the region in which our graduates are becoming to work.

We propose several subjects spread between graduate and postgraduate degrees. Most of these subjects and their contents come from the current profile. It is highlighted that *Learning Systems* and *Speech Technology* subject are removed. Instead, we propose a subject called *Web Engineering* in the graduate degree and another called *Mobile and Ubiquitous Computing* in the postgraduate degree. The *Multimedia, Hypermedia and Virtual Reality* subject is separated in two subjects. One of them in the graduate degree is called *Multimedia and Hypermedia*, and the other one is in the postgraduate degree bringing together contents of *Virtual and Augmented Reality*. Finally, the *Collaborative Systems* subject changes its name in order to take an engineering approach and is called *Groupware Engineering*. Tables 4 and 5 show this information in a summarized way.

Table 4. Subjects in the new proposal of HCI in Computer Science and Engineering (four years graduate).

Type	Subject	Semester	ECTS
Compulsory	Human-Computer Interaction Systems (HCIS)	3	7,5
Elective	User Interfaces Development (UID)	4	3,5
Elective	Multimedia e Hypermedia (MH)	5	3,5
Elective	Web Engineering (WE)	6	3,5

Table 5. Subjects in the new proposal of HCI in Computer Science Master (postgraduate).

Type	Subject	Semester	ECTS
Elective	Groupware Engineering (GE)	1	3,5
Elective	Mobile and Ubiquitous Computing (MUC)	2	3,5
Elective	Virtual and Augmented Reality (VAR)	1	3,5

It is important to empathize that the HCIS and UID subjects are proposed to be studied in earlier semesters. In particular, HCIS should be studied once the students have some knowledge of computer programming and are learning methods and techniques of Software Engineering. Immediately afterwards, the study of *User Interfaces Development* is proposed. This is not a new initiative because in previous work this was already proposed and some universities adopted this approach several years ago (according with [18]). In the next semesters specific knowledge about Multimedia, Hypermedia and Web is introduced. Finally, the specific contents about other interaction paradigms are located in the postgraduate with a practical and professional focus towards an immediate connection to industrial work. This helps to provide the importance of the user interfaces development in the process of software development and to close the curriculum of professionals to the request of the companies.

Also, the postgraduate with research focus which has to conclude in the doctoral dissertation can be addressed to the HCI area in Computer Science. In particular, our approach and challenge is to propose methods, techniques and tools for the design and development of systems supporting work in group and mobile computing.

Table 6. Relationship between proposed subjects and recommendations of international associations

Subject	ACM/IEEE	SigCHI
Human-Computer Interaction Systems (HCIS)	HC1, HC4	Introduction, C1, C2, C3
User Interface Development (UID)	HC2, HC5, HC6, SE2	U2, C5, D2, D3
Multimedia and Hypermedia (MH)	HC7, IM12, IM13, NC5, NC7, NC8	U2, C5, D2
Web Engineering (WE)	HC5, GV1, NC5	C4, D1, D2
Groupware Engineering (GE)	HC2, HC4, HC8	U1, U2
Mobile and Ubiquitous Computing (MUC)	HC2, HC4, NC4, NC9	C5, D4
Virtual and Augmented Reality (VAR)	GV10	C1, C4, D4

Considering these changes, the profile practically covers all contents of HCI recommended by the Computing Curricula of ACM/IEEE and by the SigCHI of ACM, at least those that have a greater impact on software companies in Castilla-La Mancha region (and nearby regions such as Madrid). Table 6 shows the relationship between these contents and the international recommendations.

5. Summary and concluding remarks

In this paper, we have presented a proposal for organizing the HCI curriculum in Computer Science and Engineering studies in order to be considered in the new syllabus and courses of the ESI at UCLM. This proposal comes from previous and positive experience of an Interactive Technologies profile. After a career of 10 years this profile requires some adjustments. In addition, this need is reinforced as a result of the new regulation for the university studies in Spain and their adaptation to EHEA.

The new proposal we made covers the trajectory beginning with fundamental aspects requested by software companies. These fundamentals are stated in the graduate degree at the same level as other concepts of Software Engineering. More specific aspects related to interaction paradigms are contained in the postgraduate degree. Finally, the creation of new knowledge related to methods, tools, procedures and techniques of engineering for HCI in Computer Science is proposed in order to train new researchers. This new proposal is better adapted to the recommendations of international associations for what is considered the HCI core fundamental in Computer Science and Engineering as for the specializations that are emerging in order to define specific curricula such as the Software Engineering or Engineering in Information Technology.

We hope that this proposal will begin in the academic year 2009/2010 and will throw practical results allowing an assessment by comparison with the current curriculum and contrasting its suitability with the needs of the society in which our graduates, post-graduates and researchers develop their professional activity.

6. ACKNOWLEDGMENTS

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