An Introductory Course on Human Computer Interaction

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Resumo - **Apresenta-se resumidamente o programa, métodos de ensino e bibliografia da disciplina de Interfaces Humano Computador que tem sido oferecida desde 1993/94 como opção da Licenciatura em Electrónica e Telecomunicações da Universidade de Aveiro.**

Abstract – **An introductory course on Human Computer Interaction offered as an elective to the Engineering degree on Electronics and Telecommunications at the University of Aveiro is presented. Its contents, teaching methods and bibliography are briefly described.**

I. INTRODUCTION

When computers first appeared on the commercial scene in the 1950s they were cumbersome and very difficult to use; since then dramatic decreases in the cost of computing resources have resulted from new technological advances; in less than thirty years computers changed from being huge machines (housed in large air-conditioned rooms) to much smaller machines, including ones that can be carried around. The development of the first personal computers in the 1970s was a landmark because these machines provided interactive computer power for individual users at low cost. These changes have opened up a wide range of new possibilities for the way in which computers can be used. Computing is becoming ubiquitous.

Ordinary people began using computer systems, and for computers to be widely accepted and used effectively they need to be designed for the needs and capacities of the people for whom they are intended. However, computer professionals, namely software engineers, have been extensively trained in ways of thinking that are very different from those of most possible users of computer systems and tend to judge their work by criteria that may have little to do with the needs and constraints of the end user. For example, efficiency of code and flexibility of architecture are relevant engineering goals but are not enough to guarantee the success of a computer system in being accessible to, and supportive of, a particular type of user; thus a carefully designed user interface is a determinant factor.

In the 1980's a marketing brochure (for the Aple's Macintosh) focused, for the first time, decidedly on the human interface. This was an important evolution since publicity and attention was brought to computer-human interface as a selling point; it signalled a new attitude on the part of the computer industry toward this aspect of software products. The motivation for this change in attitude, and the then new and still growing interest in computer-interaction, came mainly from the fact that much more resources could be dedicated to the human computer interface without sacrificing functionality, performance or cost effectiveness. In fact, the user of computer technology is now often a person who is technologically uneducated, unsophisticated and unmotivated, rather than a professional technologist. Acceptable and appealing interfaces, as well as desired functionality, must be offered. Certain kinds of users simply will not buy or use systems which require too much of an investment in learning. To serve this kind of user, products must be very easy to learn.

At an individual level, user interfaces change many people's lives: doctors can make more accurate diagnoses, children can learn more effectively, graphic artists can explore more creative possibilities and pilots can fly airplanes more safely. Some changes however are disruptive; too often, users must cope with frustration, fear and failure when they encounter excessive complexity, incomprehensible terminology, or chaotic layouts.

Effective systems generate positive feelings of success, competence, mastery and clarity in the user community. The users are not encumbered by the computer and can predict what will happen in response to each of their actions. When an interaction system is well designed, the interface almost disappears, enabling users to concentrate on their work, exploration or pleasure.

There is a endless desire for increased productivity among computer users and organisations. Small improvements in productivity on a task can add up to significant organisational benefits when the number of users and volume of transactions are high, thus human performance in the use of computer systems will remain a rapidly expanding research and development topic in the coming decades. The interdisciplinary field of Human Computer Interaction combines the data gathering methods and intellectual framework of experimental psychology with the powerful and widely used tools developed from computer science and engineering. This is the environment where any professional who develops S/W applications has to move. Thus, nowadays, a basic education in Human Computer Interaction is very important.

In 1991, the document produced by the ACM/IEEE-CS Joint Task Force, "Computing as a Science" [1], considered Human Computer Interaction, along with Computer Graphics, as constituting Human Computer Communication, one of the nine sub-areas of Computer

Science. In 1994, the National Science Foundation in the United States of America subsidised a report on "New Directions in Human-Computer Interaction, Research and Practice" which identifies Human Computer Interaction as a fundamental field of S/W Engineering and reports difficulties in integrating it in the curricula of American Universities. Note that in Portuguese Universities, by that time, there were already courses on this subject, the one described in this work and another at Instituto Superior Técnico in Lisbon [2].

Currently, the draft of the Computing Curricula 2001 [3] includes some hours of Human Computer Interaction on the body of knowledge considered essential for all undergraduate programs in Computer Science and Engineering.

In the following sections a brief description of the general objectives, contents, bibliography and teaching methods of a course on Human Computer Interaction lectured at the University of Aveiro will be presented.

II. GENERAL CONTEXT AND OBJECTIVES OF THE COURSE

The course described in this work has been an elective offered to fifth year students of the Engineering degree on Electronics and Telecommunications, since 1993/94. During some years (until 1996/97), a few MSc students were also allowed to attend it.

Currently (since 1999/2000), the fifth year is organised in several areas and this course belongs to the core of the Information Systems area, along with courses on Data Bases and Distributed Architectures. As every student of this area attends simultaneously all core courses, it is possible to coordinate the activities performed at those courses, namely to have common practical assignments.

The specific objective of this course on Human Computer Interaction is to introduce the students to what is this multi-disciplinary field, addressing the main issues of the design, implementation and evaluation of human computer interfaces. Principles and guidelines are presented but also theoretical and experimental foundation from which they are obtained.

This course should also serve more general objectives, such as training students to be able to use adequate working methods as well as correct technical writing and presentation.

III. GENERAL CONTENTS

This course was designed to have 26 hours of lectures. Ten topics are addressed:

1- Introduction to the problem of designing the User's Interface: definition, general methodology and principles of design;
2- User's Profile and modelling: Human Information Processing System (HIPS): psychological and physical characteristics of the user; mental models.
3- Conceptual models: principles and guidelines to the development of conceptual models;

4- Dialogue styles: characteristics, experimental results applicability and principles and guidelines for the design of the main dialogue styles and their combined use;
5- User interface evaluation: significance, evaluation methods, their characteristics and applicability;
6- Input/Output devices: main existing devices and ergonomic issues;
7- Screen layout and design and colour usage: experimental results, principles and guidelines;
8- User's documentation: experimental results, principles and guidelines for the design of manuals and help on-line;
9- Software for User Interfaces: Windows Management Systems (WMS) and User Interface Management Systems (UIMS) and technologies for the Web;
10- Advanced applications: Computer-Supported Cooperative Work.

In the first lecture, corresponding to topic n.1, a general introduction to the area is made. Besides presenting the definitions and goals of Human Computer Interaction, the great importance of the user's interface is stressed: a significant part of the effort to produce an interactive application is devoted to the user's interface to which the success and acceptation of that application is strongly related. A general description of the main principles and guidelines that should be followed in the design of the user's interface is presented.

Topic n.2 is concerned with the "human part" of the interaction process. The importance of knowing the profile of the intended users is stressed and the characteristics to be considered in its definition are introduced. An overview of the most relevant aspects of the Human Information Processing System is presented stressing that they have important implications for design and that users, in spite of sharing common capabilities and limitations, are individuals with differences which should not be ignored. Some models of the user are introduced and mental models are presented.

Topic n.3 introduces conceptual models: experimental results are described and principles and guidelines to follow in the design of conceptual models for user interfaces are introduced; metaphors are also addressed.

Topic n.4 introduces a classification of dialogue styles (seven styles: direct manipulation, menus, question and answer, fill-in-forms, function keys, command languages and natural languages) as a taxonomy which helps understanding the characteristics and applicability of each style; this classification is useful in spite of the fact that, in general, several styles are used simultaneously and the frontiers between them are often blurred.

Topic n.5 is concerned with evaluation; it is introduced as an absolute necessity nowadays. A range of methods is presented along with their applicability: expert reviews, usability testing, surveys and continuing assessment.

In topic n.6 an introduction to the most common input/output devices is made stressing the increased concern on human factors that has steered the development of new

versions of old devices. Issues related to keyboards, pointing devices, devices for speech recognition and generation as well as displays are briefly described. Some novel devices are also referred.

Topic n.7 deals with screen layout and design as well as the problem of using colour effectively; some principles and guidelines are presented and the power and dangers of using colour are addressed (related to the psychophysical characteristics of the Human Visual System and cultural issues).

Topic n.8 addresses the design of supplementary materials, in both paper and online form, always needed to help users. Several types of user's written or online documentation are introduced, as well as the main principles and guidelines that should be followed in their design.

Topic n.9 introduces the general issues related to Windows Management Systems and Graphical User Interface Management Systems.

Finally in topic n.10, the design and evaluation of new technologies to support the social processes of work, often among distant partners, are introduced.

This is the general content of the *curriculum* adopted in this course as it has been applied in 1999/2000 and 2000/2001. It has evolved, according to the experience obtained each time it was taught. This evolution is expected to continue; several subjects already considered important are still missing in this *curriculum* and others are becoming relevant as information visualization or virtual reality the new paradigm for interaction. However this *curriculum* is already heavy as it is and the introduction of new topics should be carefully analysed.

On the second semester of the current academic year (2000/2001) another course on Human Computer Interaction will be lectured to 3rd year students of Computers and Telematics Engineering. These students have different background and interests; this will imply some changes in the way this course is lectured. The authors believe the main changes will be needed in the teaching methods, practical assignments and evaluation methods. Since this new course will have 39h of lectures, some more topics will be addressed, however the general content and bibliography seem to support equally well these new students.

IV. BIBLIOGRAPHY

There are several books that cover the contents of this course and can be used as textbooks. However, until now several books have been used to support the course, recommending to the students one or two for each subject, according to the approach they use. Other references are used to support specific topics (web sites or papers), which are not included in this bibliography. In the next section the general usage of this bibliography is described and some comments are provided.

A. General usage of bibliography

The first bibliographic reference (of the list presented in the next section), the text by Shneiderman is the one having a general organization which is believed to better support the current overall structure of the course; it is a comprehensive and up-to-dated text, however most topics are also addressed, with the right approach, in the texts by Preece et al. and Dix et al.. The former addresses in much more detail the issues related to user interface evaluation. The reference by Mayhew is not as comprehensive, however it gives a much more thorough view of the principles and guidelines that should be observed in the user's interface design; this characteristic makes it most useful and it has been used as the main reference to support several topics concerned with dialogue design.

The book by Nielson has been used to support practical assignments on evaluation.

The book by Tufte is generally very interesting and has been used specifically for the topic of colour usage.

The textbook by Hearn and Baker has been used to support the study of input/output devices.

B. Commented bibliography

Shneidermen, B., *Designing the User Interface, Strategies for Effective Human-Computer Interaction*, 3rd ed., Addison Wesley, 1998
Provides a complete and current introduction to user interface design, namely the principles and practices needed to design an effective interaction. It includes human factors for interactive software, tested methods to develop and assess interfaces, interaction styles and design considerations such as effective messages, consistent screen design and appropriate colour.

Dix, A., J. Finlay, G. Abowd, B. Russell, *Human Computer Interaction*, Prentice Hall, 2nd ed., 1998
It is a textbook, providing a multidisciplinary perspective of the subject. It covers the basic psychology and computer technology involved in the interface between humans and computers, as well as usability and advanced topics. This edition includes new material on virtual reality and ubiquitous computing, design for the Internet and information visualization among other topics.

Mayhew, D., *Principle and Guidelines in Software User Interface Design*, Addison Wesley, 1992
This book differs from the previous two texts; it is a practical text that provides available principles and guidelines for the design of user interfaces, plus research data and theory from which they are drawn. Based on extensive review of research and practice in human-computer interaction, it discusses software user interface in detail.

Preece, J., I. Rogers, H. Sharp, D. Benyon, S. Holland, T. Carey, *Human Computer Interaction*, Addison Wesley, 1994
Offers a comprehensive account of this multidisciplinary field illustrating the powerful benefits of a user-oriented approach to the design of modern computer systems. It balances technical and cognitive issues required for understanding the interplay between people and computer, particularly in new fields as multimedia, virtual environments and computer supported cooperative work.

Nielsen, J., *Usability Engineering*, Academic Press, 1993
It is a guide to the methods of usability engineering and helps non technical people improve the systems so that they are not only free of errors but also easier, more pleasant to use and more efficient.

Tufte, E., *Envisioning Information*, Graphics Press, 1990
This book reveals the design strategies for enhancing the dimensionality and density of portrayals of information. General principles of information design, which are universal, help to identify and explain design excellence – why some displays are better than others. It includes several hundred displays of complex information and a section on colour usage.

Hearn, D., M. P. Baker, *Computer Graphics*, 2nd ed., Prentice Hall, 1994
This can be considered a textbook on Computer Graphics; it includes a chapter on input/output devices and colour models using a different approach from the one generally used in Human Computer Interaction texts.

V. TEACHING METHODS

Elective courses of the degree in Electronics and Telecommunications Engineering have 2 hours of lectures and 2 hours of practical classes per week. This results, for a typical semester, in ≈26 hours of lectures and 26 hours of practical classes.

Every year (until 1996/97) a few MSc students, who wished to get some background on the area, were allowed to attend this course. These students were submitted to a different evaluation; they had more demanding implementation assignments, as the ones described in [4-10]. Evaluation, for all the other students, has always been based on an examination and practical assignments; however practical assignments have been of different nature along the years. In the first editions, team projects were developed involving several students (≈8). This type of assignment was interesting, however implied that some one would play the part of project leader and integrator of the different parts developed by the students [11,12]. MSc students, under the supervision of the teacher, have carried out this job. Later on, these assignments were replaced by two practical assignments to be executed by groups of two students: one involving the evaluation of user interfaces of S/W applications, web sites or even non-computational systems (as a video recorder or a video camera) and a second assignment involving the design and implementation of a user interface.

Since 1999/2000, the final assignment involving design and implementation of a user interface has been common to the courses on Data Bases and Distributed Architectures. This organization allows the students to have an integrated view of the design and implementation of a more sophisticated application, including management of the information as well as the server and client parts, "behind" the user interface.

The first practical classes have been used to introduce HTML and Visual Basic and to explore and modify some simple dialog boxes. This year, as several students needed to use XML for their graduation projects, this language was also introduced. These initial classes prepare students to implement their own final assignments. Another practical class is devoted to the evaluation of web sites. The remainder practical classes are used to discuss and develop the final assignments.

Students have to submit a report corresponding to each practical assignment; they also have to make short presentations. Since most of the students usually feel very uncomfortable with these tasks, some time is spent explaining how to write a technical report and make oral presentations [13].

VI. WHAT FUTURE?

The contents, bibliography and teaching methods of an introductory course on Human Computer Interaction at the University of Aveiro, was presented. This course was designed to be an elective course for the fifth year of a degree on Electronics and Telecommunications Engineering and has been offered since 1993/94. In the academic year of 2000/2001 it will become a mandatory course of a degree on Computers and Telematics Engineering and will be lectured at the 3rd year. In order to adapt the presented course to the new type of students some modifications will be needed. We believe that this modifications will occur mainly on the teaching methods, evaluation and practical assignments since the general *curriculum* and bibliography seem *a priori* to support equally well the needs of both types of students; however only teaching experience will validate this assumption.

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