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# Principles for Human-Centred Design of IR Interfaces

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**Abstract.** Since the '80s, Human-Computer Interaction (HCI) researchers have performed a lot of work to identify principles, techniques, and methodologies that can support design, evaluation and implementation of interactive systems that fulfill needs and expectations of their users. This chapter discusses concepts, such as usability and user experience, which are of great importance for the success of interactive systems, illustrating how Human-Centred Design is fundamental to create successful user interfaces. Principles proposed by the HCI community to support interface design are presented, analyzing the principles that have a major impact on IR interfaces.

**Keywords:** user interfaces, usability, user experience (UX), design principles

## 1 Introduction

Before the advent of the web, Information Retrieval (IR) systems were used almost exclusively by librarians and information professionals, such as paralegals and journalists. They were frequent and expert users, who, after an initial training phase, somehow tolerated the complexity of a command-line interface. Today the rapid increase of web-based accesses to IR systems has completely changed the use scenario. Also users have completely changed, since now almost every person accessing the web uses a search engine. According to a survey, made by Pew Internet & American Life Project, in February 2012 the web was accessed by the 80% of American adults population [1] and about 90% of them used online search engines [2]. Before the Web, a search for a document consisted in accessing the IR system where only data about the source of the document were available; such data allowed to get the physical copy of the document in order to get the full text. By exploiting the advance of technology, from networked database systems to graphical displays, the Web provides an enormous amount of content of different types, which includes not only traditional unstructured documents but also multimedia information (images, audio, video) about people, companies, organizations, etc. Moreover, it can be searched by directly asking questions such as: "What is the amount of water vapor in the air?".

This new scenario has pushed towards a completely new way of designing the IR system user interface that, as for any interactive system, is a critical component because it has a great impact on the users' performance and satisfaction. This chapter describes Human-Centred Design as the approach for creating successful interfaces,

able to generate a positive User Experience (UX), and illustrates principles that support interface design, analyzing the principles that have a major impact on IR systems.

## 2 Usability of interactive systems

It is widely acknowledged that *usability* is a crucial factor of the overall quality of any interactive system. One of the first and most representative definitions is proposed by J. Nielsen within a model of the acceptability of the system by its end users, which reflects whether the system is good enough to satisfy different needs and requirements of the users [3]. In Nielsen's model, one of the *system acceptability* characteristics is its *usefulness*, decomposed in *utility* and *usability* (see Fig. 1). Specifically, utility considers if the functionality of the system can do what users need, while usability considers how well users can use that functionality. Usability is itself a multi-dimensional characteristic, and the following five dimensions are considered by Nielsen (see Fig. 1): *learnability*, i.e., the ease of learning the functionality and the behavior of the system; *efficiency*, i.e., the level of attainable productivity, once the user has learned the system; *memorability*, i.e., the ease of remembering the system functionality, so that the occasional user can return to the system after a period of non-use, without needing to learn again how to use it; *errors*, i.e., the capability of the system to support users in making less errors during the use of the system and, in case they make errors, to let them easily recover; *satisfaction*, i.e., the measure of how much the users like the system. The latter dimension must not be underestimated, since a system pleasant to use increases users' productivity.

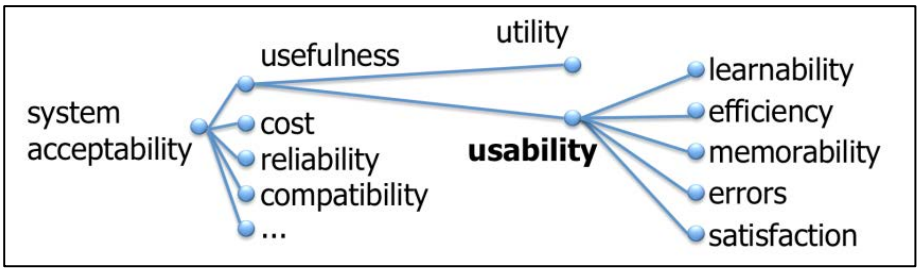


**Fig. 1.** Nielsen's definition of usability as decomposed into five sub-characteristics (adapted from [3])

Despite all the work carried out by HCI researchers in defining methods for ensuring usability of interactive systems, the many problems that people still encounter in interacting with various systems show that usability has been so far very much neglected by software developers. Actually, usability was already mentioned in the original definition of the standard for software product quality. In a more recent formulation, the standard ISO/IEC 9126-1 (Information Technology - Software Product Quality) emphasizes the importance of designing for quality, focusing on intrinsic system features which can help to create products which are effective, efficient and satisfying

for the intended users [4]. The overall quality of a software product is given by its internal and external capability to support the achievement of the goals of users and their organizations, thus improving productivity and human health. The standard describes a model for software product quality, which includes internal quality, external quality and quality in use, each one decomposed in a number of characteristics that should be properly measured (Fig. 2). Usability is one of the six characteristics of external quality and it is defined as "the capability of the software product to be understood, learned, used and attractive to the user, when used under specified conditions". Specifically, it is further subdivided into five sub-characteristics: *understandability*, i.e., the intrinsic capability of the software product of showing to the users its appropriateness to the tasks to be accomplished and to the context of use; *learnability*, i.e., the intrinsic capability of the software product to help users to easily learn its functionality; *operability*, i.e., the intrinsic capability of the software product to make possible for the users the execution and the control of its functionality; *attractiveness*, i.e., the intrinsic capability of the software product to be pleasant for users; *compliance*, i.e., the capability of the software product to adhere to standards, conventions, style guides about usability.

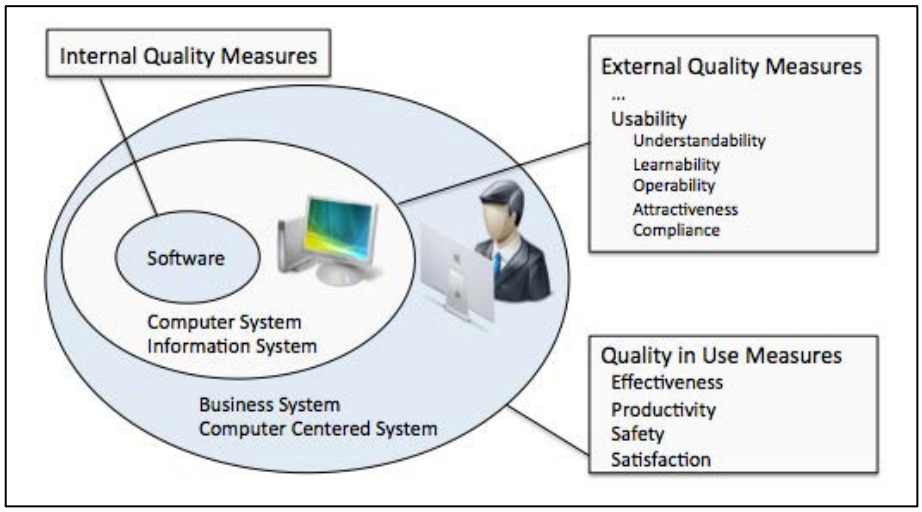


**Fig. 2.** Software qualities in ISO 9126. Usability is one of the six characteristics of external quality and it is further decomposed into five sub-characteristics

The ISO 9126 standard introduces the concept of *quality in use* to address the interaction between user and software product, which is measurable only in the context of a real and observable task, also taking into consideration different relevant internal attributes, such as usability. Quality in use is defined in terms of characteristics that represent the user's view of the software quality, i.e., *effectiveness*, *productivity*, *safety* and *satisfaction*. These characteristics are very much related to those defining usability in another standard, the ISO 9241 (Ergonomic Requirements for Office Work

with VDTs) [5], which is the standard of reference of the HCI community. In part 11 (Guidance on Usability) of the ISO 9241, the following definition is provided:

> *usability* is the extent to which a product can be used by specified users to achieve specified goals with *effectiveness, efficiency and satisfaction* in a specified context of use.

*Effectiveness* is the accuracy and the completeness with which specified users achieve specified goals in particular environments. *Efficiency* refers to the resources expended in relation to the accuracy and completeness of goals achieved. *Satisfaction* is defined as the comfort and the acceptability of the system for its users and other people affected by its use. Usability is therefore intended as a high level goal of system design. We may conclude that both concepts of quality in use and usability, as defined in ISO 9241, incorporate the most significant characteristics generally associated to usability by the HCI community.

All usability definitions remark that usability is strictly dependent on the particular circumstances in which a product is used, i.e., the nature of the users, the tasks they perform, and the physical and social environments in which they operate. Therefore, the designer has to carefully analyze those circumstances in order to reach a good degree of usability of the developed product.

## 3 Human–centred design

Having a clear understanding of what usability means, the very problem is "how to obtain usability" or, in other words, how to design systems that users find usable. One of the reasons why many high-tech products, including computer-based systems as well as electronic equipment and everyday appliances, are so hard to use is that during the development of a product, the emphasis and focus have been on the system, not on the people who will be the ultimate end user. Developers counted on the fact that humans are flexible and adaptable, they can better adapt to the machine rather than vice versa. Human needs have been neglected in the past also because engineers were developing products for end users who were very much like themselves, since there was not yet the explosion of different types of end users we have today or, like in the case of IR systems, end users were people who used the system very frequently so that, after an initial training, they became somehow able to cope with systems difficult to use. With the large spreading of computers everywhere, the target audience has changed dramatically and keeps changing every day. One of the main requirements of the information technology society is to design for universal access, i.e., computer systems must be accessible by any kind of users. What has been done in the past does not work for today's users and technology. Designers must allow the human users to focus on the task at hand and not on the means for doing that task. Thus, methods and techniques to help designers change the way they view and design products, methods that work from the users' needs and abilities, have been developed.

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The approach that has already proven as a key factor for leading towards the development of successful interfaces is Human-Centred Design, also called User-Centred Design (UCD) [6], [7]; it implies that final users are involved from the very beginning of the planning stage, and identifying user requirements becomes a crucial phase. Early involvement of users has the potential for preventing serious mistakes when designing innovative systems. Indeed, it compels designers to think in terms of utility and usability of the system they are going to develop. Benefits of UCD are mainly related to completeness of system functionality, repair effort saving, as well as user satisfaction. Involving users from early stages allows basing the system core on what is effectively needed. Poor or inadequate requirements specifications can determine interaction difficulties, including lack of facilities and usability problems. Even if late evaluations are useful to assess the usability of final systems, it is unrealistic to expect that these results cause a complete redesign.

The basic principles of UCD are: 1) analyze the users, the tasks they perform and the context in which they operate; 2) design and implement the system iteratively through prototypes of increasing complexity; 3) evaluate design choices and prototypes, possibly with users. UCD requires understanding reality: who will use the system, where, how, and to do what. Then, the system is designed iterating a design-implementation-evaluation cycle. In this way it is possible to avoid serious mistakes and to save re-implementation time, since the first design is based on empirical knowledge of user behavior, needs, and expectations. These principles have been captured in the standard ISO 9241-210 (Human-centred design for interactive systems), that is shown in Fig. 3. The design solutions mentioned in the model are implemented through prototypes that are evaluated and, if they do not meet the specified requirements, the process is iterated and goes again through a revision of the requirements and the proposal of a new prototype. The iterative process is stopped when requirements are met. It is evident that evaluation plays a critical role. It is highly recommended to evaluate early prototypes, e.g. paper mock-ups, sketching the screens of the visual interface, because the earliest interface problems are detected, the easiest is to correct them with very limited cost. Chapter [Catarci & Kimani in this book] discusses different evaluation methods.

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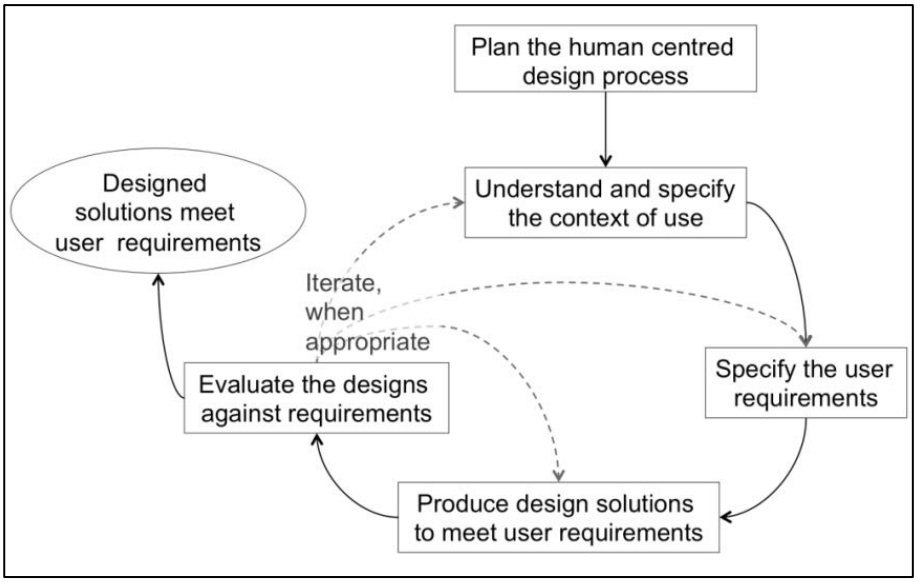


**Fig. 3.** ISO 9241-210 "Human-centred design process for interactive systems"

## 4 From usability to user experience

Over the last years, the concept of usability has been evolving, along with the emerging IT landscape. HCI has become increasingly concerned with user experience (UX), including subjective attributes like, for instance, aesthetic, emotions, and social involvement in a design space which has previously mainly concerned with ease-of-use. The tenet of UX is well expressed by McCarthy and Wright [8]:

*"Today we don't just use technology, we live with it. Much more deeply than ever before we are aware that interacting with technology involves us emotionally, intellectually and sensually. So people who design, use, and evaluate interactive systems need to be able to understand and analyze people's felt experience with technology".*

Until recently, a primary goal of product and service design has been to provide useful and usable functionality to allow people to perform their tasks. These goals are still important but, having so many goods and services now available, we have to make sure that they are pleasurable as well. Pleasure and fun are important components of life: learning, education, work can all benefit from pleasure and fun [9]. UX is still a broadly defined term, including satisfaction of non-instrumental needs (e.g. aesthetic, hedonic, creative and social), and acquisition of positive feeling and well-being. Neither a universal definition of UX nor a cohesive theory of experience yet exists that can inform the HCI community on how to practically design for and evaluate UX, although efforts have been undertaken to develop UX conceptual models [10]. For definition of UX, see, for example, [11].

Traditional usability is characterized as task-oriented and performance-based. Some researchers observe that the three canonical usability metrics – effectiveness, efficiency, satisfaction – basically address not only the instrumental aspects of technology use, but also the non-instrumental ones, since satisfaction is a composite term, amalgamating a cluster of "felt experience". What the current UX research emphasizes is the composition of satisfaction into elemental attributes related to people emotions, such as pleasure, fun, surprise, intimacy, joy, and others, and try to understand, define and quantify such attributes.

It is now acknowledged that designing for experience includes but it is much more than designing for efficiency and other traditional attributes of usability. While efficiency is focused on attributes such as fast, easy, functional, error-free, UX involves feelings and thus focuses on beautiful (harmonious, clear), emotional (affectionate, lovable, erotic), stimulating (intellectual, motivational), and also on tactile (smooth, soft), acoustic (rhythmic, melodious) in case of multimodal interfaces. The experience of a user with a product is certainly influenced by functional quality attributes of the product (e.g. utility, robustness), by non-functional quality attributes (e.g. usability, privacy) and by specific user experience attributes (e.g. desirability, pleasure).


**Fig. 4.** (a) Car controls at the beginning of 1900s; (b) car controls at the end of 1900s; (c) devices in a today's car

Today's emphasis on UX, after many years of focus on usability, is not surprising, since it is typical of many other technological products. Initially, designers concentrated on utility of the new product. As industry sectors mature, the focus goes towards usability and, later, user experience. Fig. 4 and Fig. 5 report two examples. At the beginning of 20th century, a car was a useful, even if uncomfortable, means of transportation, with a user interface (car controls, see Fig. 4a) different from a model to another. During the last century, cars were becoming more and more usable and confortable, with standardized car controls (Fig. 4b). Today, cars are equipped with several devices (GPS navigator, multimedia devices), in order to provide a positive UX for all people traveling in the car (Fig. 4c). The other example is about TVs. The TV first introduced in the market was black and white, with a very limited number of channels (Fig. 5a). Later, color TVs were produced and were provided with a remote control, which made the TV much more usable, since it could be operated while comfortably seating on a sofa. Today, TV provides a much greater experience: TV is in-

teractive, 3D, connected to the Internet. It is interesting to note that the remote controls for these TVs have many buttons and are often not very usable (see Figure 5c), and yet, because of the overall positive experience users get, they accept these complex devices.


**Fig. 5.** (a) Black-and-white TV; (b) color TV with simple remote control; (c) 3D interactive TV connected to the Internet, with complex and little usable remote control

Summarizing, a product, able to generate a positive UX should be useful, usable, and desirable. In order to create desirable products, UX puts a lot of emphasis on pleasure and thus, on aesthetics and fun. Aesthetics is today much more stressed, even if attractiveness was always considered a characteristic of usability. Aesthetics is very important also in the design of IR interfaces. Some studies show the correlation between aesthetics and the perception of interface quality [12], [13]. It has been shown that interfaces aesthetically appealing are perceived more useful even when they are slightly less useful than an interface with similar functionality but less attractive [14]. Other studies point out the importance of a good layout with proper colors, font styles, blank spaces, showing how small details actually have a great impact on users' perception of the interface. For example, in [15] it is reported that the appropriateness of several graphic design details contributes to a good user experience with Google.

## 5 Principles for good design

As we said in the previous section, a positive user experience makes people more tolerant with respect to some usability problems of a product. Still, usability is very important in order to get a positive UX. Since the '80s, the HCI community has identified various recommendations for designers willing to create usable interfaces. Some of them are expressed in a positive way, such as "choose this solution in order to reach this goal". Others are expressed in a negative way: "don't do this in this situation". Some design recommendations are more general, some are more compulsory. Often, in literature, words such as principles, guidelines, design rules, style guides are used as synonyms. We prefer to be more specific, distinguishing four categories based on different generality and compulsion levels, as shown in Fig. 6.

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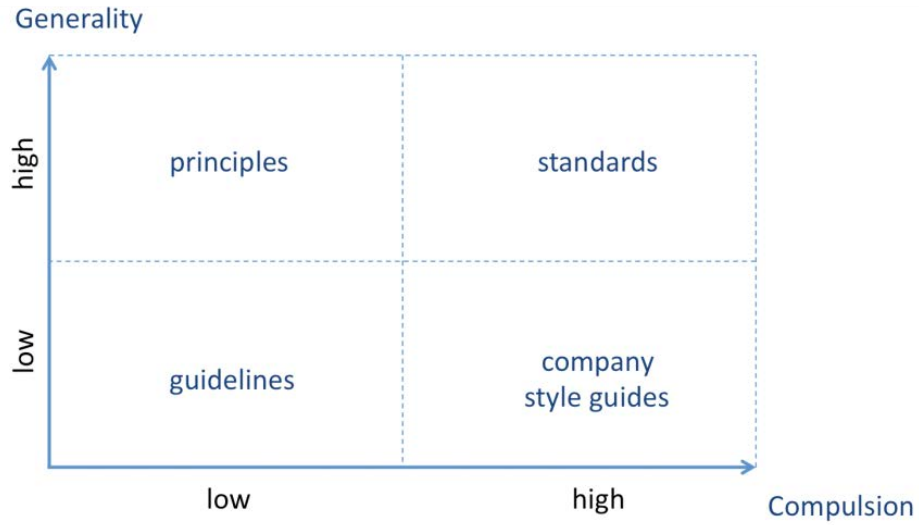


**Fig. 6.** Classification of design recommendations (adapted from [16])

*Principles* are more fundamental and widely applicable rules, derived from scientific evidence and general consensus, taking into account psychological and social aspects of human beings, rather than technology. Expressed in general form, they are more enduring. *Guidelines* are more specific recommendations for the design of a certain class of systems, i.e. they are narrowly focused. *Standards* are design rules formulated by an international organization; they must be strictly observed if one has to comply with those standards. *Company style guides* (or company design rules) are very detailed rules to be applied in the design of company systems, so that their user interfaces will have similar look and behavior.

In this chapter, we address design principles, in particular those more relevant for IR interfaces. Many collections of specific guidelines are proposed in the literature, for example the reader may refer to [17]. As an example of standard, the already mentioned ISO 9241 contains guidance on user interfaces design and provides requirements and recommendations, which can be used during the design and evaluation of user interfaces [5]; it reports seven basic and general design rules, called dialogue principles, as well as more specific rules addressing various details of the design of different interface styles, e.g. form-based interfaces, graphical interfaces, etc. Finally, several companies have defined their stile guides, in order to provide indications that their third parties have to strictly follow in developing applications for that company. For example, see the style guides developed by Apple for mobile applications [18].

### 5.1 Traditional usability principles

In the last twenty five years, different authors have proposed sets of design principles which, from one side, offer a way of better understanding usability and, on the other side, provide guidance for a "good design". In his book published in 1993, Nielsen

provides ten usability principles, also called usability heuristics, which aim at providing useful indications, not only for the design but also for the evaluation of user interfaces; they are the basis of a well-known inspection technique called heuristic evaluation [3]. Since its formulation in 1993, the ten heuristics have been modified only very slightly; in fact, these are general principles that depend very much on characteristics and behavior of human beings, rather than technology. Thus, while technology changes rapidly, human beings psychological and social aspects do not. Nielsen's heuristics are discussed by many authors and can also be found at [19]; they are reported in Table 1, together with a brief comment that illustrates each heuristic.

**Table 1.** Nielsen's heuristics for usability [19]

| N. | Heuristics | Explanation |
|---|---|---|
| 1 | **Visibility of system status** | the system should always keep users informed about what is going on, through appropriate feedback within reasonable time |
| 2 | **Match between system and the real world** | the system should speak the users' language (words, phrases and concepts familiar to the user, rather than system-oriented). Follow real-world conventions, information should appear in natural/logical order |
| 3 | **User control and freedom** | users often choose system functions by mistake and will need a clearly marked "emergency exit". Support undo and redo |
| 4 | **Consistency and standards** | users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions |
| 5 | **Error prevention** | a careful design prevents a problem from occurring in the first place. Eliminate error-prone conditions. Present users with a confirmation option |
| 6 | **Recognition rather than recall** | minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember dialogue information |
| 7 | **Flexibility and efficiency of use** | accelerators – unseen by the novice user – may often speed up the interaction for the expert user. Allow users to tailor frequent actions |
| 8 | **Aesthetic and minimalist design** | dialogues should not contain information, which is irrelevant or rarely needed. Extra units of information diminishes of relevant units |
| 9 | **Help users recognize, diagnose, and recover from errors** | error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution |
| 10 | **Help and documentation** | even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation |

Shneiderman proposes eight golden rules, which summarize his view of the key principles of interface design [20]. Other design principles are presented by Dix et al., divided into three main categories, which refer to learnability, flexibility, robustness, for a total of fourteen principles [21]. The ISO 9241 proposes its own set of principles. Of course, one can easily expect that most of those principles are actually the

same, even if they are phrased in a slightly different way. A basic principle mentioned by most author is *consistency* (see heuristic 4 in Table 1), which recommends designers to create user interfaces which are consistent, e.g., they show a consistent input/output behavior in similar situations or, in the case of visual interfaces, use consistent colors, layout, fonts. Another well recognized principle is about *feedback* to be provided to users during the interaction. Nielsen refers to it as v*isibility of the system status* (see heuristic 1 in Table 1), since the interface has to keep users informed about what is going on in the system, providing appropriate feedback about user actions (e.g., highlight a folder to indicated that the user has selected it) or system operations (e.g.. show a progress bar which indicates the current status of a file download).

A very important principle when designing for usability refers to *user control* (see heuristic 3 in Table 1). Even today, many novice users are afraid of approaching interactive systems since they do not feel in control of the system. They want comprehensible and controllable environments. On the other side, the technology tries to support people through systems that are pro-active and anticipate users' operations whenever it is possible. Thus, user interface designers must properly balance the actions automated by the system, which sometimes users might not easily understand, and the users being in control through the actions they perform. Designers should know that users are allowed to make mistakes, so that they have to provide mechanisms for easily recovering from such mistakes. Clearly marked emergency exit, possibility of undo and redo, are powerful mechanisms to keep the user in control of the system. Other principles refer to users' errors and remark the importance of *preventing users' errors* during the interaction, as well as of providing ways to *easily recover from errors* (see heuristics 5 and 9 in Table 1). There are many detailed guidelines that have been derived from these two principles and the reader may refer to them (see, e.g., [17]).

The success of the graphical user interfaces developed since the '80s, which replaced the language-based command interfaces like UNIX® or MS-DOS®, relies on the fact that, for human beings, recognition is better than recall. A corresponding principle (see heuristics 6 in Table 1) is that the interface has to be designed in order to *minimize the user's memory load* by making objects, actions, and options visible, so that the user must not remember dialogue information. For a novice or infrequent user it is certainly more efficient to identify an operation and execute it if it is well represented by an icon or a menu item clearly visible or easily retrieved on the interface screen, rather than to remember the difficult and error prone syntax of an MS-DOS command. However, a good design must also take into account that users are very diverse and that they evolve during time, e.g. a novice user became expert in the use of the system after a continuous use of it. Thus, a further recommendation for designers is to create *flexible interfaces*, which provide mechanisms to accommodate the needs for different types of users, e.g., accelerators that may speed up the interaction for the expert user (see heuristic 7 in table 1).

Heuristic 2 in Table 1 recommends that the system has to speak the user's language, i.e. words, concepts, icons, etc. that are familiar to the users have to be used in the interface. Heuristic 8 recalls that users must not be overloaded with too much information on the screen and suggests to eliminate information rarely needed, which

will be available only on users' demand. It also recommends to design interfaces which are simple, paying special attention to graphic details and to the overall aesthetics. Finally, heuristic 10 is about the proper use of help and documentation, especially when the system is rather complex. The documentation should be ready to use, e.g. online help or other types of online documentation. For example, during some tests we observed that users had difficulties in understanding how to use the interface of a portal with many widgets, and they required the help of a more expert person; we next provided the interface with short video-guides (about three minutes long) explaining the main functionalities of the interface, that users can watch on demand. Such video-guides encouraged users to interact without the help of an intermediary person.

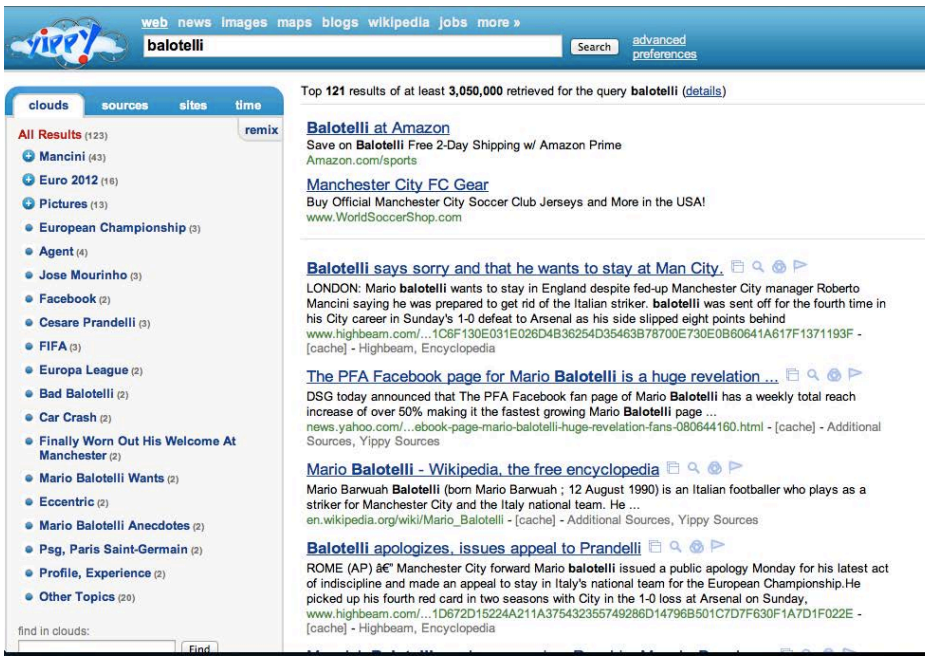


**Fig. 7.** Results of searching "balotelli" in Yippy search engine

### 5.2 More specific design principles for IR interfaces

In the book "Search User Interfaces Design", Wilson suggests to take into account primarily the ten heuristics proposed by Nielsen [22]. Principles that have a major impact on the design of IR interfaces have been discussed by Hearst in Chapter 1 of her book [23]. She actually speaks of "design guidelines" but, according to our classification in Figure 6, they are general design principles rather than guidelines. Some of the principles that Hearst reports for IR interfaces are actually applicable to user interfaces of any type of system, and have been described in the previous section, namely *provide feedback*, *reduce short term memory load*, *provide shortcuts*, *reduce errors*. Three other principles mentioned by Hearst are: *balance user control with automated*

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*actions, recognize the importance of small details, recognize the importance of aesthetics*. Aesthetics has been discussed at the end of Section 4, highlighting how appropriate graphic details have a very positive impact on the users' perceived quality of the user interface. The reader may refer to Chapter 1 of [23] to see several interesting examples that illustrate the importance of such principles in IR interfaces. In the rest of this section, we discuss three other principles which are very significant for designing IR interfaces capable to provide a positive UX: *simplicity, pleasurability* and *customizability.*

As reported in the introduction, the Web has completely changed the interface of IR systems and its users. Almost any person accessing the Web uses an online search engine. Designers of web search interfaces have to take into account the need of novice and occasional users as well as those of expert and frequent ones. This diversity of end users is one of the main reasons for keeping the interface simple. *Simplicity* is today one of the main principles guiding the design of a search interface: both query formulation and analysis of the search result should be simple. Several studies showed that novice users have difficulties in very basic activities, such as formulating keyword queries and understanding that they do not immediately get the results they seek, but they have to look at the query results and to further navigate in the Web in order to possibly satisfy their information need; examples of such users are children at their first experiences with search interfaces [24], [25]. Designers have to consider that, in most cases, many results are returned to a user query, and such results have to be presented in order to support users to figure out what are the most significant for them and how to proceed to possibly refine such results. For example, the Yippy search engine adds a panel reporting a classification of the top results. Fig. 7 shows the screen obtained when searching for "balotelli". Besides the usual list of the top results, the panel at the left side reports a classification automatically computed by the engine. By clicking on the first item, e.g. 'Mancini' only the 43 results in this cluster are shown. The first three clusters have a plus on their left indicating that a finer classification is available. Another main reason for keeping the interface simple is that nowadays search engines are often used while the user is engaged in a different task, and search is not her/his primary goal. The search interface has to be as simple as possible to avoid distracting the user and to limit the interference with the user main task. "Make things simple and intuitive" is actually one of the main indications provided by designers of UX.

Hess lists 20 guiding principles for Experience Design [26]. Some of them enhance simplicity in the design by recommending principles such as *present few choices*, *limit distraction*, *avoid jargon*, *less is more*. Indeed, providing more alternatives to people makes the choice much more difficult; it is much better to keep the interface simple, providing only the necessary alternative and removing all the less important ones. People have to be concentrated on their current task, and the interface should favor this by avoiding to distract them with less critical tasks. Designers should keep in mind that users are not like them and are very different among themselves, so that the dialogue with the users has to be simple and clear, using a language that users may easily understand. Finally, the design should show only the very necessary and useful information, making sure that any element in the interface has a purpose; it can be a

functional purpose or only an aesthetic one. Anything that does not actually contribute to a positive experience should be removed or the user should have the possibility to remove it. Let us consider two examples of showing previews of retrieved web pages. Fig. 8 shows the screenshot of the results obtained by searching "balotelli" with Lycos search engine. A thumbnail of the preview is on the left of each result. Fig. 9 shows the results of the same query, obtained with Google. For each result the user can visualize the preview by moving the cursor to the right of each result. Two arrows will appear and, by clicking on such arrows, the preview is shown, as in Fig. 10. Some very informal test we have performed by asking adult people to compare these two alternatives show that Google solution is preferable since the preview is only on-demand and it is shown at a better resolution.

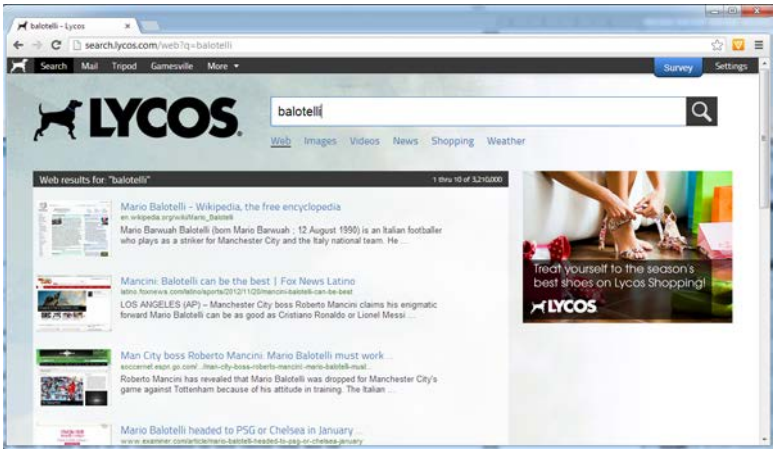


**Fig. 8.** Results of searching "balotelli" in Lycos search engine

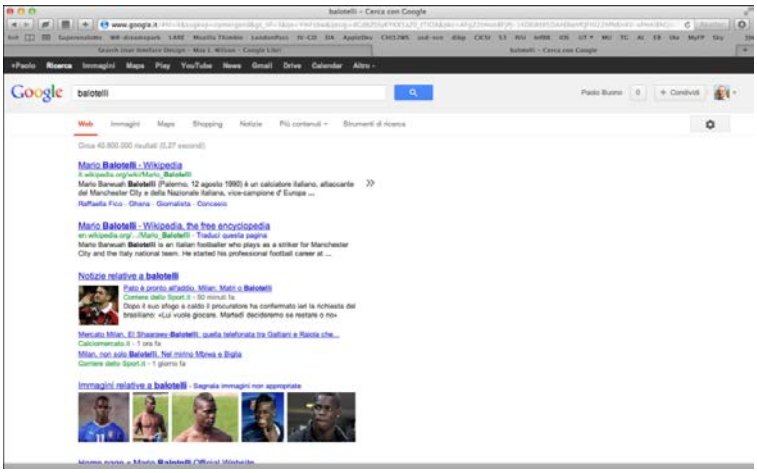


**Fig. 9.** Results of searching "balotelli" in Google search engine

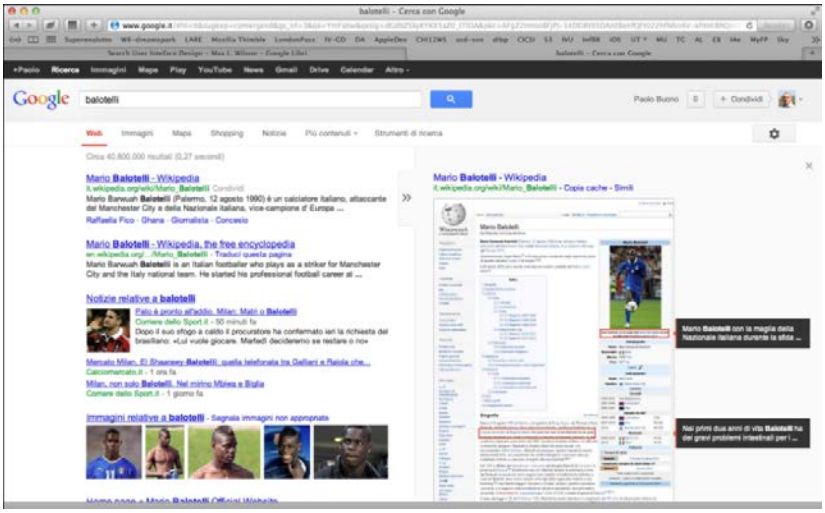


**Fig. 10.** Preview shown in Google when hovering with the mouse pointer on the arrows on the left of an item result

Some of the remaining principles proposed by Hess for UX design are similar to usability principles previously commented, e.g., *make actions reversible*, *provide feedback*, *be consistent*. Some others provide suggestions for creating interfaces that are easy to understand and use, and also help people to orient themselves and to be in control of the dialogue, e.g., *group related objects near each other*, *use appropriate defaults*, *create a visual hierarchy that matches user's needs* (by appropriately using colors, size position, shape in order to aid in understanding and processing the presented information), *provide signposts and cues*, *use constraints appropriately* (in order to prevent errors and to guide people to successful interactions).

Nothing really specific is suggested by Hess about designing for *pleasurability*. A well-known slogan when referring to UX is "Make stuff easy and pleasurable to use". This is the consequence of the shift from usability to UX, the latter emphasizing much more subjective emotions, such us fun, engagement, joy, all contributing to create pleasure for the user. A lot of research is going on in order to define models of UX that can serve as a basis for giving designers guidance to cope with the emerging principle of *pleasurability*. UX has a much richer scope that traditional usability, essentially because more attention is devoted to users' emotions, affects, motivations and values that contribute to *pleasurability*. However, currently available UX design principles are much more detailed about those aspects characterizing usability (i.e., easy of learning, ease of use and basic subjective satisfaction), while a little is yet said about *pleasurability*, i.e., about emotions. In the Hess's list, *use emotion* is the only principle addressing the more subjective component of UX. It emphasizes that pleasure is very important and recommends designers to create interfaces that are simple and intuitive for users, without being boring or cold but capable to generate pleasure. Every UX designer pushes for pleasurable interfaces, which can motivate and stimulate persons and make them feel engaged, but specific guidelines are not yet available.

In contrast to usability, standard UX metrics are yet to be defined, as well as benchmark that suggest competitive design artifacts and help selecting the right design options. Of course, there are various attempts to measure aspects of the UX. In [27] and [28], it is proposed and evaluated a multidimensional scale to measure user engagement when interacting with technology and in particular with IR systems. Models of UX are also needed to understand, predict and reasoning about processes of UX and their consequences for software design, in order to provide a sound basis for UX measures with desirable properties, such as reliability, sensitivity, validity. Even if some first results are coming, a number of issues about UX modeling remain to be solved [29].

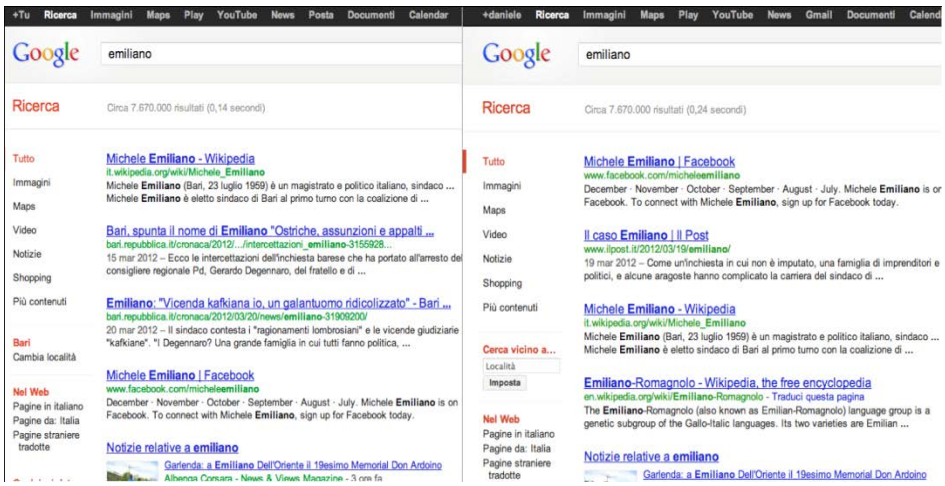


**Fig. 11.** Results obtained in different order for the same search performed at the same moment by two persons in two different countries

The latter principle discussed here is *customizability*. It was not mentioned in the original 10 heuristics of Nielsen and in the 8 golden rules of Shneiderman, since only more recent technology makes possible to create software that it is easy to adapt, in ways that have to be very intuitive for the users and can make them a lot happier. Dix et al. report *customizability* as one of the principles that affect flexibility [21]. It is also mentioned as a basic principle in the ISO 9241, indicated as *suitability for individualization*. In its wider meaning, *customizability* actually refers to the personalization of the user interface performed by the system or by the user. Personalization accomplished by the system is often called system adaptivity, while the other is called adaptability by the user. Adaptivity is performed if the system, by considering contextual properties, like the current task or situation, or even monitoring users' behavior, is capable to adapt itself for the benefits of users. The following example shows that searches on Google are adapted by the system by taking into account the geographic area in which the user operates. We have asked two persons to perform a search by inputting the word "emiliano" at the same moment but in two different locations: in

Bari, our city in South Italy, and in a town of Finland. The screenshots in Fig. 11 show the results of the search performed in Italy (left) and in Finland (right), respectively. The number of results is the same (7.670.000 items), but the order of the results is different. Emiliano is last name of the Bari's major, so for the person in Bari the first result is an item in Wikipedia presenting the major, while for the person in Finland the first result is the Facebook page of Emiliano.

Adaptability occurs when the system allows users to perform modifications; they may go from simple parameter setting, in order to choose among alternative presentations or interaction mechanisms, to more complex activities that imply modifications and/or creations of software artifacts. Such activities are actually examples of End-User Development (EUD) [30], [31] and reflect the new trend toward a more active involvement of end users in tailoring software tools and environments to their own needs [32]. Of course, end users have to be empowered to shape the software they use without being obliged to become programmers [33], [34]. Some EUD-oriented techniques have already been adopted in software for the mass market, such as some Programming by Example techniques in Microsoft Excel™.

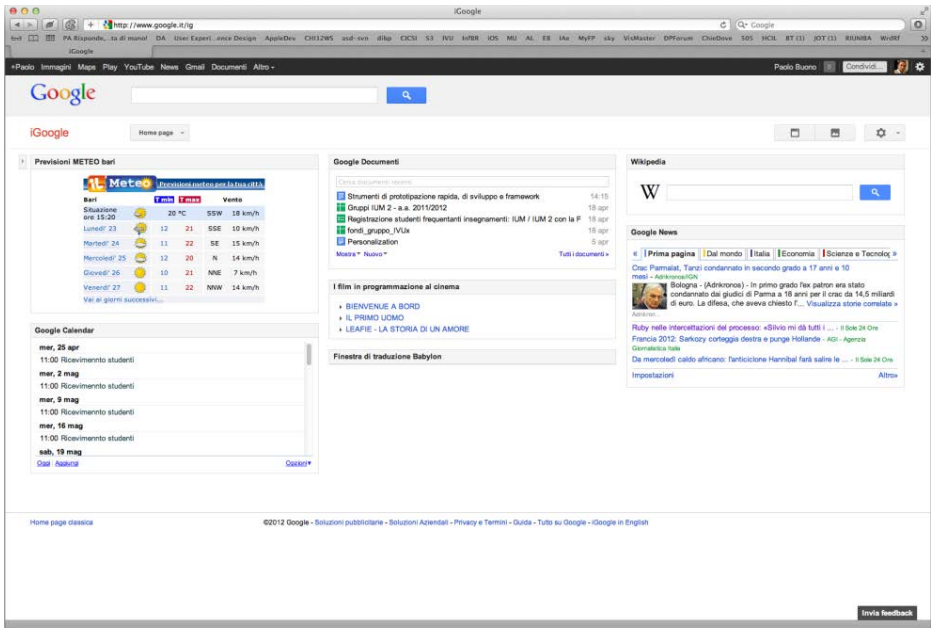


**Fig. 12.** iGoogle interface customized by a user

So far, search engines have not provided adaptability features, but the situation is quickly changing. For instance, iGoogle™ is an online dashboard in which a user can add widgets of interest. Let us suppose that a user asks every day for weather information. Instead of accessing every time to a weather forecast website, the user may add in his/her iGoogle™ dashboard a weather forecast widget, already set with the geographic area of interest. Every time the dashboard is opened, the weather forecast

is available to the user, as shown in Fig. 12. The weather forecast widget is actually a service that the user has added to the dashboard in a very simple way, by clicking on a button available in the iGoogle interface. A page with the more required services is shown to the user, who has also the possibility of searching for other services accessible through the Web. Once the user has selected the service of interest, he/she clicks on the 'Add' button and the widget associated to the service is added to the dashboard, where he/she can position it in the more convenient place.

iGoogle is an example of the new trend to replace fixed, pre-packaged applications with elastic composition environments that allows end users, not necessarily experts of technology, to extract contents and services from various sources and to compose personal information spaces that satisfy their own needs and that can be used on different devices [35], [36].

We conclude by summarizing, in Table 2, the main principles that support designers in creating IR interfaces able to provide a positive UX. The first seven principles where already discussed by Hearst in [23]. The last three have been discussed in this paper.

**Table 2.** Principles for designing IR user interfaces

| N. | Principles |
|---|---|
| 1 | Offer efficient and informative feedback |
| 2 | Balance user control with automated actions |
| 3 | Reduce short-term memory load |
| 4 | Provide shortcuts |
| 5 | Reduce errors |
| 6 | Recognize the importance of small details |
| 7 | Recognize the importance of aesthetics |
| 8 | Keep the interface simple |
| 9 | Design for pleasurability |
| 10 | Enable users to customize the interface |

## 6 Conclusions

This chapter has presented principles to guide the design of successful user interfaces. The shift from usability to UX has been discussed emphasizing that, in order to generate a positive UX, a software product should be useful, usable and desirable. Design principles that have a major impact on IR interfaces have been analyzed. Very significant are those discussed by Hearst [23]. We have complemented them with three oth-

er principles, which focus on simplicity, pleasurability and customizability of the interface, respectively. A lot of emphasis is currently given to such characteristics by both researchers and practitioners, as discussed in the last part of the chapter.

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