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Autor: Bolchini, Davide / Yu, Eric S. K.

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DAVIDE BOLCHINI* & ERIC S. K. YU**

MODELLING USER REQUIREMENTS FOR WEB APPLICATION DESIGN

Web applications are designed to communicate for a diversity of purposes to a multiplicity of users with a variety of goals. Analysts have to manage this complexity by modelling user requirements and provide proper guidance to the web design activity. This paper introduces a framework based on user profiles, roles and goals for describing and analysing web user requirements. Project teams can use these conceptual tools for systematically envisioning salient user scenarios at a proper conceptual level. The information gathered through the analysis feeds into a goal-oriented requirements engineering method, which facilitates the transition from requirements to web design. Excerpts from the design of a real museum web site are discussed as a case study.

Keywords: user requirements, user profiles, scenarios, goals, roles, persons, web applications, web design.

*University of Lugano, davide.bolchini@lu.unisi.ch

**University of Toronto, yu@fis.utoronto.ca

1. Introduction

Modern web sites are designed to fulfill two sets of objectives: the communication purposes of the stakeholders who conceived the web site, and the needs of the potential users. Consider a university web site. On one hand, it may aim to attract new students and raise its profile to gain international attention; to this end, the site may promote the success factors and distinctive features of that university. On the other hand, different kinds of users should be supported in the accomplishment of their tasks. Prospective students may want to check the quality of the faculty members, evaluate the facilities offered, campus life and professional opportunities. Current students may want to access the course information of a given department, or check the timetable and contact faculty members. Researchers may want to see the projects being carried out, check for open positions in a given area, find potential research partners.

As web sites are used by corporations and institutions more and more as structured means of communication, stakeholders and designers should presuppose an intended target audience (Van Der Geest 2001). The more the characteristics and the expectations of the addressees are considered, the more the chances are that designers deliver a satisfactory user experience.

The problem is that potential web site users are often unknown from the outset, have different characteristics and have a variety of motivations and needs, which are difficult to identify at the beginning of a project for effective accommodation in the design. Effective guidance has still to be provided to less-experienced project teams to support them in systematically manage the complexity of user requirements. On the basis of a proper understanding of user requirements, designers have then to decide how to shape the user experience.

Methods for analyzing user requirements should have a number of “ideal” features, including:

- a. they should significantly improve the quality of the requirements gathered in a web project, thus allowing for a more structured and reasoned input to the design activity;
- b. they should be lightweight and sufficiently informal to be easily accessible by less-experienced analysts and web designers;
- c. they should not force designers to take “all” or “nothing” of the methodology proposed. Each web project has distinctive features for which any method only partially fits. Designers should be able to

- effectively use only some modules or some ideas of a method without making more cumbersome the whole pre-design work;
- d. they should provide ways not only to understand and analyze user requirements but also to communicate the results of the analysis within interdisciplinary teams (involving graphic designers, developers and stakeholders).

This paper introduces a modelling framework for defining user requirements in view of supporting a user-centered design for complex web applications. Starting from known general practices in the interactive application design arena, the model presented in this paper is founded on the notions of user *persons*, *goals* and *roles* and tries to explore the different aspects composing the user requirements and to provide usable yet analytic conceptual tools to project teams. The outcome collected from using this approach can then be fed into a more comprehensive technique of goal-oriented requirements analysis (not entirely illustrated in this paper), which provides a structured input to the design activity.

With respect to the abovementioned success features of a user requirements model, the proposed approach tries to cover quite effectively point b), c), and d), whereas to fulfill the requirements for a) further empirical research on a higher number of projects is needed.

The remainder of the paper is organized as follows. Section 2 illustrates relevant limits of current techniques for conducting user requirements analysis. Section 3 explains the key notions of the proposed approach for modelling user requirements. A process guide explaining how the concepts may be used and represented during the development lifecycle is discussed in Section 4. Section 5 summarizes the lessons-learned from an informal validation based on project experience, and outlines hints for the future work. Finally, section 6 draws some concluding remarks.

2. State of the Art and Related Work

2.1. *Limits of Current Approaches to "User Profiling"*

Current practice in web development considers the identification of the *user profiles* as the starting point of the user requirements analysis (Cato 2001) (Garrett 2002) (Kuniavsky 2003). A user profile describes stable archetypal qualities of a relevant target segment (Carroll 2002) and may

comprise a variety of attributes based on demographic (e.g. age, gender, occupation, eventual disabilities etc.) or “webographic” (e.g. net usage habits, interests, hardware and software constraints, favorite sites, etc.) (Garrett 2002). For example, Figure 1 shows some examples of user profiles identified for a museum web site¹.

| | | | |
|------------------|------------------|------------------|-------------------|
| Profile_1 | | Profile_4 | |
| Occupation | Teacher | Occupation | Tourist |
| Age | 25-50 | Age | 25-50 |
| Net usage | 0.5 hour per day | Net usage | 1-2 hours per day |
| Access speed | Ethernet | Access speed | 56 KB/sec |
| Languages | German, English | Languages | English |

| | | | |
|------------------|-----------------|------------------|-------------------------|
| Profile_2 | | Profile_5 | |
| Occupation | Student | Occupation | Journalist |
| Age | 15-25 | Age | 35-60 |
| Net usage | 2 hours per day | Net usage | 4-8 hours per day |
| Access speed | 56 KB/sec | Access speed | Ethernet, 56 KB/sec |
| Languages | German, English | Languages | German, English, French |

| | |
|------------------|-------------------------|
| Profile_3 | |
| Occupation | Art Critic |
| Age | 35-60 |
| Net usage | 0.5 - 3 hours per day |
| Access speed | 56 KB/sec |
| Languages | German, English, French |

Figure 1: Synoptic of primary user profiles.

Profiles can be discovered through a variety of requirements elicitation techniques based on user research, such as surveys, contextual inquiry, focus groups and structured interviews. Whatever technique is used, the definition of user profiles plays an important role in identifying the spectrum of the target audience to which the web site is addressed.

A commonly used way of representing user profiles is the use of *personae* (Cato 2001; Garrett 2002; Cooper 2002). A *persona* is a fictitious and concrete character representative of a target audience represented with a name, a picture, an age (not a range), specific interests and features. *Personae* are envisioned by designers and analysts on the basis of the

¹ The example is excerpted by the early phase of the user requirements analysis carried out for the web site of the Munch's collection of the Berliner Gemaldegalerie of modern art. Requirements and design are coordinated by the Technology Enhanced Communication Laboratory (TEC-Lab) of the University of Lugano (www.tec-lab.ch), in collaboration with the HUC laboratory at the Politecnico di Milano.

results of some user research. Defining a set (two or three) of key *personae* may be helpful as a communication tool between the team and to vividly identifying the actual people who will use the application.

At a closer look, a profile (and even a *persona*) aggregates *several dimensions* characterizing a target user. For example, *age* is a dimension that may define orthogonal user groups comprising of several profiles: independently from habits, net usage and occupation, people who are respectively 15-20, 25-35, 35-50, 50-60 years old have different expectations and typical tasks with respect to the content of the museum web site. Therefore, their needs and requirements may need to be addressed separately from other dimensions (such as occupation, net usage, etc.). Similarly, across different ages, occupations, habits and cultural backgrounds there might be users with respectively slow (28Kbs-56Kbs), fast (56Kbs-256Kbs) and super fast (>256Kbs) Internet connections; they have thus different access requirements to be taken into account in the analysis. *Language* is another important attribute that is common to several profiles and may need to be separated in order to design content accommodating different cultural requirements. The level of *user knowledge* with respect to the site is an example of another important cross-profile dimension to consider. It is known that, for example, access paths to content and navigation shortcuts needed by experienced users radically differ for the ones needed by first time users (Paolini 1999). The level of background knowledge may also concern domain-specific characteristics. In the museum web site, we may want to distinguish between “art experts” and “non art expert” for designing different content and cultural paths within the site. Also in this case a non art expert may cross several profiles defined in Figure 1 (e.g. an art expert can be a teacher or a journalist), and yet needs to be taken into account separately from the others (see Figure 2).

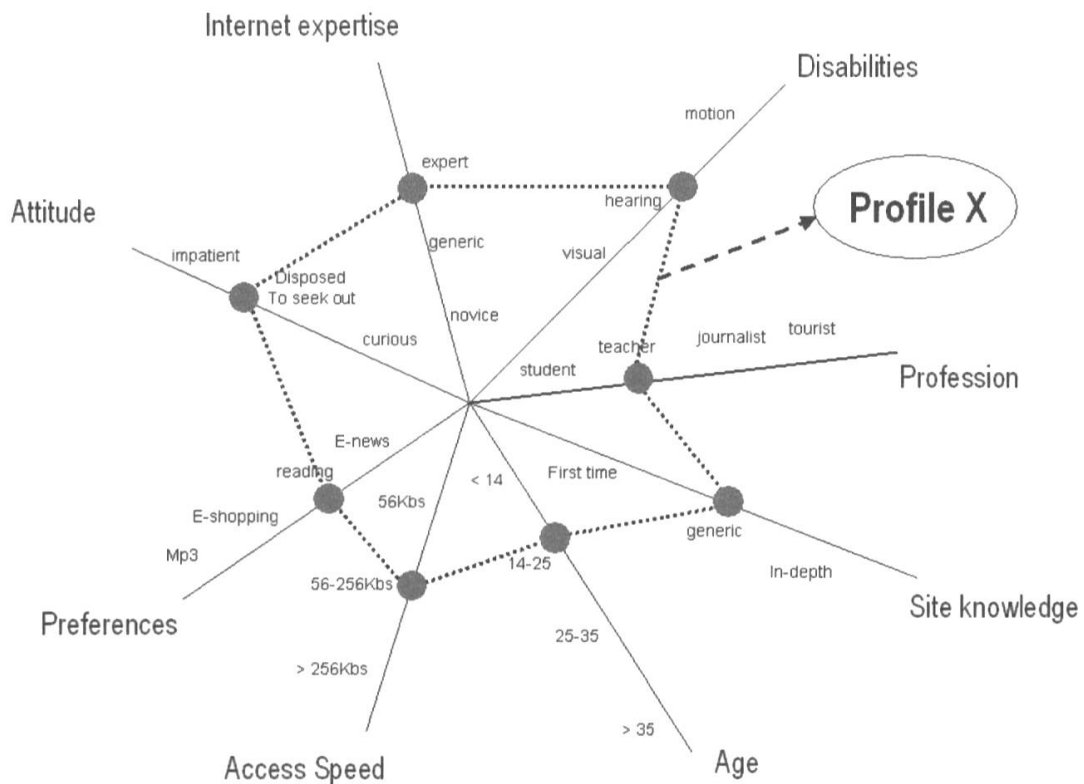


Figure 2: Some examples of possible user dimensions to consider. Current practice implicitly aggregates from the outset several user characteristics to define user requirements.

Many of these dimensions concerning user characteristics are orthogonal and may be treated separately (instead of aggregate them from the outset), based on the principle of separation of concerns. The conventional approach to user profiles forces the analysts to aggregate a set of user characteristics in a profile early in the analysis, with the risk of preventing designers to discover user needs that are common to several profiles. Therefore, we want to identify the different contributions that compose a user profile to be able to analyze them separately and then combine them to create a richer set of user requirements.

2.2. Limits of Current Understanding of “User Tasks”

Following the guidance of the current practice in web development, once user profiles are identified, tasks and goals are usually associated to each profile. In fact, a user may access a web site for a variety of purposes: find-

ing specific information, gathering elements to take decisions, getting an idea of the content offered, etc.

Current practice to user requirements analysis often reduces the investigation and understanding of user goals to an activity commonly referred to as *task analysis*.

Basically, the question that task analysis tries to answer is: *What will the user do with the web site?* User tasks are envisioned targets of achievement and courses of actions the user might want to accomplish on the web site. In this user-centered perspective, tasks are analyzed and decomposed providing an input for the design activity.

In Human-Computer Interaction (HCI), task-based techniques for interface design acknowledge that one or more tasks may be associated to a user profile (Marchionini 1995). However, tasks always tend describe precisely-defined and focused aims of the user interaction, assuming that the user has always clear in mind a specific objective for coming to the website and a punctual information to look for (e.g. finding a product, finding the company phone number, retrieve the name of the author of a paper, and so on). Thus, tasks span from the objective of the user interaction to the detailed sequence of actions (up to actions performed on interface) the user will do to complete the tasks.

Whereas these fine-grained user needs represent important types of tasks to consider for the users, they are not the only one, and – moreover – they are the easiest to support.

In the museum example, the user profile *Teacher* may have goals such as *Organize an educational visit*, *Prepare introductory lesson before the visit*, *Get useful catalogue for teaching*, or *Decide about taking the class to the museum*. On the other hand, the user profile *Art Critic* might want to *Check comments of other critics*, *Keep up to date on recent publications*, and *Explore the history of a work of art*.

User goals may be very broad, open-ended and ill-defined when coming to the site, and may then change and specify along the session. Goals should be regarded as *high-level* user objectives and should therefore precede the definition of tasks. It is important to consider that, in practice, the level of granularity of goals gathered during requirements elicitation (through interview or focus groups with samples of users) may vary considerably. It covers a continuum from operative tasks (describing a user action such as: *Find work of art X*) to ill-defined goals (describing a wished experience such as: *See if the museum is worth visiting*).

User goals may bring to consider also general *expectations*, in contexts where user needs are not necessarily pre-formed in a clear-cut fashion when visiting the web site. Web users who are really challenging for web designers are those who have unfocussed goals and unconsciously assign to the site the responsibility of going beyond expectations and prompting goals in the user's mind. In fact, designers should consider that web site users often have a vague understanding of the goal of their interaction just because they do not have a precise objective (Bolchini 2003). One of the main challenges for the design activity (which makes it a non-trivial activity) is to consider these ill-defined or open-ended user motivation and goals and try to accomodate them into the design. In this perspective, a shift of modelling paradigm is needed from considering only finely grained user tasks to analyze open ended *goals* and motivation, so to broaden the spectrum of user needs to consider.

According to a Requirements Engineering (RE) terminology, ill-defined goals may be consider as a special type of *softgoals*, being softgoals defined as qualitative expectations as opposed to functional achievements (Chung 2000). In a museum website, the profile may have the general expectation of finding *accurate* descriptions of the works of art on the museum web site. Similarly, the Art Critic expects the bibliographical information about an author to be *current*. A tourist might easily leave the site if *attractive* content about the collection is not immediately presented. Given these examples, it may be argued that content should always be accurate, current and attractive (and requirements analysis should not state the "obvious"). However, it is useful to define to whom these quality attributes are more relevant, in order to organize the design effort according to the resources (e.g. time and budget) available.

2.3. *Limits of Current Use of "User Scenarios"*

One of the strategies to elicit user goals is to encourage stakeholders, user representatives, analysts and designers to elaborate *user scenarios* through interviews and focus groups. User scenarios are *stories about use* (Carroll 2002) known and widely used both in HCI and RE as informal descriptions of episodes of use (or "success stories") of the application which can stimulate designers to reflect upon concrete circumstances of interaction. In web site development, scenarios are used for requirements analysis (Broadbent 2000), conceptual design (Garrett 2002) (Cato 2001) and evaluation (Brinck 2002). For the analysis of user requirements, scenar-

ios can inspire the identification of user goals because they consider a specific user in her everyday context, detailing the circumstances from which goals and motivation may arise. Referring to the museum website project, an example of a scenario defined for the profile is the following:

A high school art teacher comes to know about the exhibition of the Munch collection at the Gemaldegalerie. She has never been there but her colleagues and friends told her that it might be interesting for the pupils to visit outstanding Munch's works that were rarely made available to the public. During lunch time, she connects to the web site in the school to see in detail what the museum is about and to get a clearer idea of opportunities for her class. She reads the introduction to the collection overview and checks for the famous works of Munch. She browses the list of all works exposed in the museum and finds some interesting works that would be really worth visiting. She discovers also that there is a large collection of Munch's drawings that have never been showed to the public before. She definitively decides to take her class. However, it comes to her mind that it would be important to give an introductory lesson about Munch to prepare the pupils for the visit. Therefore, she searches for an explanation of four famous works, background information and references. Once she bookmarks the sections with needed material, she looks for the possibility of a group discount for the tickets and guided tours on working days.

A number of advantages of using scenarios are widely shared both among scholars and professionals (Carroll 2002). For our purpose, scenarios may be useful to concretely exemplify profiles and their goals, and to support communication and negotiation with the stakeholders.

However, scenarios have some *caveats* of which analysts should be aware. In fact, scenarios should not be directly translated *as they are* into site requirements or conceptual design (Güell 2000) at least for two reasons.

- a. Scenarios may introduce detailed design features (needed to envision the user interaction) that are premature to commit on; assumptions on content available, navigation and interface features should be questioned during requirements analysis and not taken for granted and decided upon.
- b. Scenarios are incomplete and partial descriptions. They should be carefully used to *suggest* possible site uses (during interviews with users and stakeholders) and as a *source* for defining high-level and general user goals. Goals have to be extracted and abstracted from scenarios and then refined in the requirements analysis.

- c. Complex websites today support a very high number of tasks or goals. It would not be feasible (and almost impossible) to have all these tasks or goals expressed in scenarios during requirements analysis. In other words, scenarios cannot cover all the interaction capabilities, but may work as important drivers for their identification.

3. Advances in User Requirements Analysis: Modelling Concepts

3.1. *Separating Concerns*

We have seen that a goal is usually associated to one or more profiles. However, since a profile is an aggregate of various qualitative and functional dimensions, we claim that decomposing further a user profile in separated concerns may help gather a more accurate set of requirements. Consider a profile (e.g. student) that contains attributes such as age, learning style and knowledge of the site. The degree of knowledge of the site (e.g. first time user, occasional user, frequent users) may vary considerably within the same age group having the same learning style (e.g. visual, kinesthetic or audio-driven). Similarly, the same learning style may vary within the same age group having the same knowledge of the site, and so on. Moreover, all these user types have their own tasks, goals and expectations with respect to the web site.

To manage this complexity and to overcome the problem of the overlapping among the criteria currently used to define profiles we introduce the notions of *person* and *role*.

3.2. *User Persons*

A *person* is a modelling abstraction used to identify a “personal” characteristic of the user. Personal characteristics (or user features) may be chosen along any dimension that analysts consider relevant for the design (see Figure 2). In the museum example, *persons* may be: first time users, experienced users, kids, parents, people between 15 and 18 years old, people over 30 years old, people with fast connections, people with slow connections, people that are not familiar with the web, people with visual disabilities, hearing impaired individuals, art experts, students, foreign tourists, local tourists, etc.

A person may be defined along any of the orthogonal dimensions (site knowledge, interests, level of disability, age, domain expertise, occupa-

tion, etc.) defining a user. In this sense, *persons* enable to explore distinctively a variety of user characteristics that profiles force to aggregate, reducing the spectrum of possibilities. Whereas a *profile* forces to define a *student* according to a predefined set of attributes (age, occupation, expectations, learning style, speed connection, preferences, attitude, usage habits, language, usual tasks), a *person* models one relevant dimension of a profile at a time (e.g. learning style), enabling the analysts to consider a wider variety of user targets along that dimension and, if relevant, combine dimensions later in the analysis.

To gain a richer set of user needs, an important dimension for defining *persons* is the user attitude (or *mind-set*) when approaching the web site. In general, attitude is defined as an affective or cognitive predisposition to respond in a particular way toward a specific class of objects (Teo 2003). In the museum example, the user may prefer an *easy guidance* within the content offered as visiting the web site for the first time. Other persons may be extremely *impatient* or *easy to irritate*, and require therefore quick access to the needed content. Considering a variety of user mind-sets is important for designing a good user experience.

How may *persons* be discovered? In the museum example, analysts may consider the website within its social, institutional (e.g. schools, media) and cultural (e.g. art world, tourism) environment; on this basis, persons are identified by exploring two key lines of reasoning:

- a. *Who does the museum want to speak to?* Setting the general audience of the web site paves the ground not only for real user-centered site design, but also for the planning the web site promotion (search engines' optimization on the target audience, targeted mailing lists, exchange links with other selected sites, etc.). Web site requirements should address the proactive communication of ad-hoc messages to a target audience whose interest to the museum should be created.
- b. *Who wants to speak to the museum?* Web site requirements should also address the support of tasks and goals of the persons who may be interested to access the web site on a regular (or non-regular) basis for professional or leisure activity (e.g. journalists, expert in cultural-heritage, local authorities).

| Priority | Person | Goals | Softgoals | Mind-set |
|----------|------------|--|-------------------------|-------------------------|
| 0.2 | Teacher | <ul style="list-style-type: none"> Organize educational visit Gather material for preparing a introductory lesson before the visit Check for given works Get useful catalogue for didactics | Accuracy | Easy guidance preferred |
| 0.15 | Student | <ul style="list-style-type: none"> Carry out a research on author, work, period, movement Study a work, period, movement, author Download interesting pictures of the work | Richness | Disposed to seek out |
| 0.1 | Art Critic | <ul style="list-style-type: none"> Check comments of other critics Check for new publications Check for recent acquisition Explore the bibliographies relative to some work of art Check the collection history Check the history of a work of art | Currency, accuracy | Disposed to explore |
| 0.35 | Tourist | <ul style="list-style-type: none"> Organize a leisure visit See if the museum is worth visiting Get an idea of the collection Check for works of famous authors Check parking possibilities | Attractive | Easily irritable |
| 0.2 | Journalist | <ul style="list-style-type: none"> Contact museum PR See if the museum is going to organize "news" events Check institutional info | Accuracy Conciseness | Impatient |

Figure 3: Person Goals.

User goals, softgoals, mind-set and priorities may be defined for each user person (see *Person Goals* in Figure 3). In fact, persons provide the basic features of the actor who is the subject of goal being envisioned. During focus groups with stakeholders and users, person goals may be elicited by questions such as: “*What might person X want to visit the site for? What are her expectations? How will she approach the site?*”

During the requirements analysis for the museum web site, we defined persons according to the *occupation* and *attitude* dimensions. *Student*, *Art Critic*, *Teacher*, *Tourist* and *Journalist* are then intersected with attitudes such as *Easy guidance preferred*, *Disposed to explore*, *Easy irritable*, *impatient*, and *Disposed to seek out*.

3.3. User Roles

Whereas a *person* describes stable personal characteristics, a *role* describes a task-related predisposition held by one or more persons interacting with a given web site. In this way, roles enable analysts to separate personal attributes from intentional characteristics. In fact, *persons* are not directly related to the intentions towards the application; a *role* instead models a behavioral attitude when visiting the web site.

In the museum example, brainstorming for user requirements with a domain expert by means of scenarios allowed outlining five key *user roles*.

1. *Casual Surfer*. The museum web site aims at attracting new people to the physical museum. Casual web surfers usually connect to the site

moved by curiosity or superficial interest about the museum and the appealing features the web site might offer. Museum stakeholders paid particular attention to this user attitude: according to the user experience within the site, simple curiosity may become real interest; real interest may in turn lead users to consider the possibility of visiting the museum (see role: Visit Planner).

2. *Picture Eager*: the visual content is the key value in a museum web site as well as in the museum experience. Analysts acknowledged the potential charm of some famous works of the collection and pointed out a user mainly interested in the visual experience provided by the site (pictures of the works, works details, authors' photos, etc.).
3. *Visit Planner*: the museum site works both as a communication means and as a support for obtaining practical information. This role models a general attitude of a user looking for all those details necessary to organize a visit (visiting hours, ticketing, etc.).
4. *Material Gatherer*: the museum web site is a rich source for collecting content that may be useful for a variety of purposes. Users may expect to find and gather high quality art material (authors' biographies, historical perspectives, descriptions, explanation and interpretation of the works of art) that the museum has the "authority" to offer to its public.
5. *Events Checker*: the organization of events is an important sign of the vitality of the museum. Both for professional and leisure purposes, users might be interested in exploring a variety of information about events (current and past), exhibitions and meeting opportunities within the museum.

Roles may vary in a continuum from domain-specific to domain-independent. On one hand, domain-specific roles may record the experience of the designers dealing with several applications in a given domain (e.g. e-commerce, cultural heritage, educational web sites). These roles crystallize requirements patterns that analysts may reuse across projects, carrying out requirements analysis more efficiently. On the other hand, recent studies in HCI identified general roles of web users (such as browsing, transacting, finding, communicating) (Abigail 2002) that can be considered across domains. For example, domain-independent roles such as *information seeker* and *information composer* may be defined. *Information seeker* may have subclasses such as *fact finder* and *info evaluator*, and so on. General task-related behaviors may help abstract the design experi-

ence and can be applied by experienced designers to several application domains. However, less-experienced designers may prefer domain-related roles, to be more easily guided to the identification of specific user goals for the site at issue.

Criteria for identification of roles are the following: a) a role should not describe any personal characteristic; b) a role should express a motivation for using the web site; c) a role should allow to envision a set of tasks and goals deriving from that motivation; d) a role may be played by one or more persons; similarly the same person can play different roles.

Reflection about user roles may generate a separate set of user goals and softgoals, with associated role priorities (see *Role Goals* in Figure 4).

| Priority | Role | Goals | Softgoals |
|----------|--------------------------|--|---------------------------------------|
| 0.2 | Casual | <ul style="list-style-type: none"> • Be attracted by something interesting • Get an idea of the collection | Attractiveness |
| 0.15 | Picture Eager | <ul style="list-style-type: none"> • Download pictures • Tell a friend | Copyright free, High-quality pictures |
| 0.3 | Visit Planner | <ul style="list-style-type: none"> • Check visiting hours • Check ticket price and discount • Reserve guided visit • See How to reach • See Where to eat • Check time expected for a visit • Be helped in selecting what to visit | Accuracy |
| 0.15 | Material Gatherer | <ul style="list-style-type: none"> • Collect works information, artistic movements and author bios • Look for works details • Compare works | Accuracy, Richness |
| 0.2 | Events Checker | <ul style="list-style-type: none"> • Look for interesting current exhibitions • Browse archive of past events • Check for planned events | Accuracy, Conciseness |

Figure 4: *Role Goals*.

Roles facilitate the definition of user goals because they suggest the intentional scope goals can arise from. The definition of *Role Goals* is easier whereas sufficient knowledge about the domain emerges by the interaction between analysts and stakeholders. A leading question for eliciting role goals may be: “*What might a user in role X do with the site? What are the expectations of a person in this attitude? How will she approach the site?*”

3.4. Priorities

As the number of persons, roles and relative goals grows, analysts and stakeholders need to solve critical trade-offs between the limited resources available (e.g. time and budget for content production) and the

user requirements to address. Indeed, an accurate user requirements analysis should identify and prioritize the target audience of the application in order to focus the communication effort and carefully spend the design resources (Garrett 2002).

To this end, *priority values* can be used to capture the importance that stakeholders (e.g. the marketing strategists, communication managers) assign to each target user. A priority value (e.g. in a range between 0 and 1) may be respectively assigned to each person (*Person Priority*) and to each user role (*Role Priority*). While the Person Priority expresses the relevance of a given target segment (e.g. *Teacher*), the Role Priority defines the importance of satisfying a general user need (e.g. *Fact finding* or *Visit planning*).

How priorities can be used? One of the possible usages of prioritization is the following: low priority goals and roles may be discarded along the project as the constraints (e.g. time available) impose simplifications of the design. Conversely, high-priority elements can be further elaborated and specified to derive requirements for the site.

4. A Process Guide

Discovering user requirements and defining a suitable web conceptual design is partly a creative process, that cannot be completely described with a methodology. However, a structured but lightweight and non-prescriptive approach may help project teams to pass from user goals to application requirements, and then to make informed design decisions. In this case, a guidance is given as to how the aforementioned concepts may play together during the requirements analysis process.

4.1. *Gathering Goals from Persons and Roles*

Ideally, persons and roles are orthogonal concepts. Thus, they may be used separately in the early stage of the analysis and then combined to obtain a rich set of user requirements.

Although the set of goals defined for the persons might partially overlap with the one defined from roles, the separation of concern between persons and roles enables analysts brainstorming and gathering a variety of goals and tasks that might have been overlooked at a superficial analysis.

This technique helps also mitigate an annoying problem analysts have to face during the negotiation with the stakeholders. Often stakeholders

think *a priori* that a target audience (e.g. students for a museum website) is extremely relevant for the site. However, when asked, it is difficult for them to imagine plausible scenarios when such a user might be interested in using the site to accomplish a goal. The analysis of user persons and roles highlights these deficiencies, whereas goals for a given person or role are missing. Actually, it might be that such users represent indeed an important segment of the stakeholders' clients but they will implausibly be interested in connecting to the web site for their everyday tasks.

Each goal is expressed informally to enable stakeholders to actively participate in the goal definition and, if necessary, revise and complete it. To this end, goal descriptions should be *rich* enough to offer a common ground for discussion and *rough* enough to be easily revised and changed. Note that, at this stage, goals may describe both high-level objectives and fine-grained tasks as well.

4.2. Creating the User Composite Profile

The systematic combination of each person (comprising its priority value, goals, softgoals and mind-set) with each role (comprising its priority value, goals, softgoals) generates a rich set of requirements for each potential target user (the *User Composite Profile*).

| | | | |
|-----------|--|-----|-----|
| Profile | Art Critic | 0.1 | 0.4 |
| Role | Visit Planner | 0.3 | |
| Goals | <ul style="list-style-type: none">• Check comments of other critics• Check for new publications• Check for recent acquisition• Explore the bibliographies relative to some work of art• Check the collection history• Check the history of a work of art• Check visiting hours• Check ticket price and discount• Reserve guided visit• See How to reach• See Where to eat• Check time expected for a visit• Be helped in selecting what to visit | | |
| Softgoals | Currency (bibliographies, literature, catalogues), accuracy (work descriptions, collection history) | | |
| Mind set | Disposed to explore, Easily irritable | | |

| | | | |
|-----------|--|-----|-----|
| Profile | Teacher | 0.2 | 0.4 |
| Role | Events Checker | 0.2 | |
| Goals | <ul style="list-style-type: none">• Gather material for preparing a introductory lesson before the visit• Organize the visit• Check for given works• Get useful catalogue for didactics• Look for interesting current exhibitions• Browse archive of past events• Check for planned events | | |
| Softgoals | Accuracy {event descriptions, catalogue info} Currency {event calendar} | | |
| Mind set | Easy guidance preferred, Disposed to explore | | |

Figure 5: Examples of two user composite profiles for the museum web site.

A *User Composite Profile* (see Figure 5) is defined by any given combination Person – Role; it outlines the goals, the softgoals and the mind-set collected from the correspondent person and role goals. The priority of a user composite profile may be obtained by combining the priority of the person with the priority of the role (e.g. average, addition, multiplication, etc.).

Information collected in each user composite profile may be redundant or inconsistent. Therefore, goals, softgoals and mind-sets may be rethought, removed, better defined or organized. In these cases, analysts have also the opportunity to ask stakeholders for clarification about requirements gathered so far and solicit them to refine the analysis on the basis of the composite profiles.

For example, for the person *Art Critic* in the role *Visit Planner*, the goals *reserve guided tour* and *be helped in selecting what to visit* (derived from the role) may be not so relevant for an art expert, and may be therefore removed for this user (erased lines). For a *Teacher* in the role *Events Checker*, all defined goals are considered relevant; however, the composite profile allows elaborating further the accuracy and currency softgoals for this user: it is important that the *event descriptions* are accurate and the *calendar of events* is up-to-date².

In the example, twenty-five user composite profiles were defined (combining five user persons with five user roles). Note that not all the user composite profiles generated are necessarily meaningful. It may happen that a given combination profile-role is improbably given in the real world and thus cannot be considered a potential user target. The combination of different goals, softgoals and mindsets collected in the composite profiles may provoke reflections on novel situations of use and provide a richer common ground for the analysis and the negotiation with the stakeholders.

4.3. From User Goals to Application Requirements

Applying goal-oriented requirements methods (Yu 2001) (Anton 1997) (Dardenne 1993) it is possible to analyze and refine goals in order to come up with a set of requirements for the web site.

² Please note that the specific decisions made in the example may not be “the right ones”. The purpose of the application example is to show the use of a methodology and not to define requirements for a museum website.

User composite profiles provide goals and tasks at different levels of abstractions, because the raw material emerged during the early requirements phase (elicitation through brainstorming and interviews with stakeholders) have different granularity and scope. A hierarchical structure may then help analysts better understand the goal set, as well as organize, analyze and communicate it to the stakeholders. To this end, user goals associated to each user composite profile are structured in a goal graph (Bolchini 2003). Figure 6 shows a part of the goal graph for the user composite profiles in Figure 5.

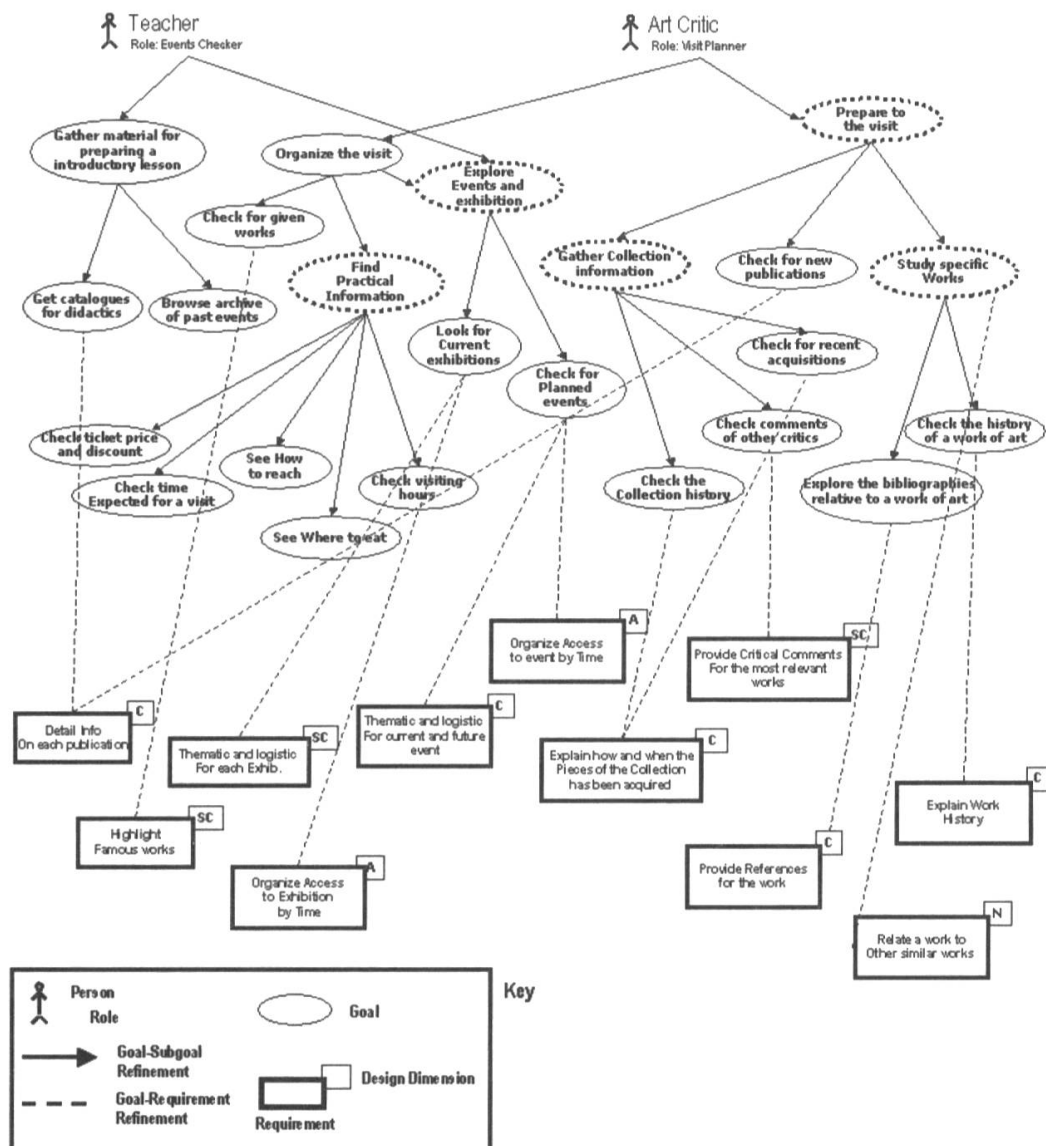


Figure 6: Excerpts of goal structuring and refinement towards hypermedia requirements.

Given a goal in the user composite profile, the structuring process is guided by *how* questions (How can the goal be satisfied?) and *why* questions (Why does the user need to achieve this goal?) (Dardenne 1993). *How* questions enable to refine goals (represented by circles) into sub-goals through a decomposition process and eventually into application requirements (represented by bold rectangles). User composite profile information such as softgoals and mind-set may help in the refinement process and in the definition of requirements. *Why* questions enable abstraction of low-level tasks into higher-level goals and point out lack of rationale for given goals. In Figure 6, high-level goals discovered in this phase are cast in dashed circles.

Requirements are the leaves of the goal graph. Whereas a goal is expressed by the user's point of view, a requirement describes the desired functionality of the web site that may contribute to satisfy one or more goals. Requirements are defined informally and, possibly, at a proper conceptual level. However, there is no "the" proper level of abstraction by which requirements should be defined. Since they are the result of an ongoing negotiation between the analyst, the domain experts, the stakeholders and the designers, the granularity of requirements is strongly dependent on the shared domain knowledge, the designer experience and the conceptual design tools mastered by the designer (Bolchini 2003).

Site requirements may concern a variety of aspects of a web application, that need to be kept distinct to facilitate and organize the design activity. To this end, requirements are classified according to their design dimension. A dimension expresses the hypermedia design aspect each requirement will have an implication on. The requirement taxonomy comprises so far eight dimensions: *Content* (labeled with C in Figure 6); *Structure of Content* (SC); *Access Paths to Content* (A); *Navigation* (N); *Presentation* (P); *User Operation* (U); *System Operation* (O); and *Interaction* (I). For detailed definition of the hypermedia requirements taxonomy (which is not the topic of this paper) we refer to (Bolchini 2003).

4.4. From Requirements to Conceptual Design

The set of classified requirements represents the actual input for the design activity. Given the requirements set, designers can read requirements "by design dimension", "by stakeholder" or "by goal". Considering requirements "by dimension" allows designers to assign requirements to specific design competences (information modelling, content editing,

navigation design, graphic design, etc.). Reading requirements “by stakeholders” or “by goal” may allow focusing, for example, on design solutions required to support “high-priority” user composite profiles.

Designers can then adopt any method or model for conceptual design such as OOHDM, UML (Conallen 2002), WebML (Ceri 2000), HDM (Garzotto 1996), or W2000 (Paolini 1999), to shape design solutions solving the requirements.

In the museum project, the W2000 design model has been used for defining the information structure, the navigation architecture and the design of the page templates according to the requirements. A web site prototype is being discussed with the museum stakeholders.

The transition from requirements to web design can be only briefly mentioned in this paper. However, it is clear that this aspect of the requirements analysis process is crucial for the quality of the user experience, since it works as bridge between the requirements definition and the actual design of the site. For in-depth research advances concerning the intersection between requirements analysis and hypermedia/web design we refer to recent results published by the authors (Bolchini 2003).

5. Validation, Limits and Future Work

The model illustrated in this paper has been used in various forms in a number of projects which highlighted both the limits and the advantages of such approach for user requirements analysis. Delivering courses and consultancy on this topic to IT professionals, an aspect which surprised them was the discovery of the possibility of treating in a systematic way the activity of user requirements. In some cases, courses to professionals were also followed by consultancy on specific industrial projects where actual designers and project managers had to carry out an activity of requirements analysis with their clients. More than specific notations or processes learned (which are easily forgotten on the long term) the persons of the design team who had been trained demonstrated an increased awareness for the relevant aspects of user requirements definition (e.g. thinking to different user characteristics *before* building up web pages) and an increased capability of documenting effectively the results gathered during this phase.

Applying this model to a number of projects (mainly in the domain of cultural-heritage and cultural tourism³) we recognized once again that

³ See projects developed at the TEC-Lab of the University of Lugano - www.tec-lab.ch

understanding how to improve the design activity of interactive applications is a challenging research task. So far, practitioners and researchers seem to converge on few common milestones (which have been partially described in section 2 of this paper) but many advances from a methodological perspective are yet to be pursued. In particular the limitations of this approach arisen from project experience include the following:

- a. the concepts and the notations illustrated should better *scale* both to small projects (where teams normally have few or no time to dedicate to user requirements analysis) and to very large projects (where goal graphs for example cannot be used to cast 30 or 40 user goals);
- b. instead of suggesting a linear and top-down process (from user profiling to web design), the model should provide more flexibility in the process. It should accommodate various *ways of thinking* when reasoning about user requirements (starting from user profiles, starting from goals, starting from content, etc) and then offering a set of notation tools according to the emerging needs of the analysis;
- c. user requirements are only a part of the set of requirements for a web application. There is a very important set of the other stakeholders to consider jointly (the client, the people who finance the application and define its communication strategy) who dictate goals and features the application should actually embody. Although there has been effort to introduce a stakeholder-centered perspective in web engineering (Bolchini 2003), the proposed model (and other existing techniques) fails to consider user's *and* stakeholder's goals in *synergy* (and not separately as currently done). One of the issues here is to understand how user goals may be influenced by the stakeholder goals (and viceversa) and how requirements may be derived from this dialogue.

Future research will focus on trying to overcome the shortcomings of the current approach by defining new and more effective conceptual tools available to project teams. Moreover, a research focus will be set on consolidating repositories of typical user roles, persons and goals in specific domains and validating the framework across large web projects.

6. Conclusions

As web applications become strategic means for corporate and institutional communication, web analysts and designers need lightweight and usable conceptual tools to manage the complexity of user requirements.

A framework for modelling user requirements has been presented, capitalizing on the potential of models already existing in the literature, and trying to overcome their limits. The model is based on the concepts of user persons, roles and goals and provides tools for taking them into account during application design. Whereas persons describe the stable characteristics of the target users; roles capture the task-related aspects of the user when approaching the web site. Persons and roles are modelled not only in terms of attributes, but also in terms of what they want to achieve, i.e. *goals*. Goal modelling allows user characteristics to be elicited and analysed at the appropriate level of abstraction, and facilitates subsequent refinement and operationalization towards conceptual design. An existing goal-oriented analysis method is then used to refine user needs into web site requirements, providing an organized input for the web design activity.

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