Mastering the Requirements Analysis for Communication-intensive Websites

A dissertation presented by
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Supervised by
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Submitted to the
Faculty of Communication Sciences
University of Lugano

for the degree of
Ph.D. in Communication Sciences

November 2003

Abstract

Web application development still needs to employ effective methods to accommodate some distinctive aspects of the requirements analysis process: capturing high-level communication goals, considering several user profiles and stakeholders, defining hypermedia-specific requirements (concerning navigation, content, information structure and presentation aspects), and reusing requirements for an effective usability evaluation.

Techniques should be usable by both stakeholders and the design team, require little training effort, and show relative advantage to project managers. Over the last few years, requirements methodologies applied to web-based applications have considered mainly the transactional and operational aspects typical of traditional information systems. The communicational aspects of web sites have been neglected in regards to systematic requirements methods.

This thesis, starting from key achievements in Requirements Engineering (hereafter RE), introduces a model (AWARE) for defining and analyzing requirements for web applications mainly conceived as strategic communication means for an institution or organization.

The model extends traditional goal and scenario-based approaches for refining high-level goals into website requirements, by introducing the analysis of ill-defined user goals, stakeholder communication goals, and a hypermedia requirement taxonomy to facilitate web conceptual design, and paving the way for a systematic usability evaluation.

AWARE comprises a conceptual toolkit and a notation for effective requirements documentation. AWARE concepts and notation represent a useful communication and analysis conceptual tool that may support in the elicitation, negotiation, analysis and validation of requirements from the relevant stakeholders (users included).

The empirical validation of the model is carried out in two ways. Firstly, the model has been employed in web projects on the field. These case studies and the lessons learnt will be presented and discussed to assess advantages and limits of the proposal. Secondly, a sample of web analysts and designers has been asked to study and apply the model: the feedback gathered is positive and encouraging for further improvement.

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Table of Contents

List of Figures

List of Tables

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Foreword

The content of this thesis is the definition of a model for the **A**nalysis of **W**eb **A**pplication **RE**quirements (AWARE). The acronym "AWARE" is suitable to indicate two important aspects of web requirements analysis that the model wants to address. The model aims at promoting in web analysts (especially novice ones), site stakeholders, and web researchers *awareness* of a variety of factors to be taken into account during the activity of requirements analysis for websites. Consequently, the approach claims to offer a conceptual toolset to manage effectively these factors. Moreover, one of the characteristics of web projects is that clients are often *unaware* of the needs a website may contribute to answer and of what the technology is capable to provide to them. Under this respect, AWARE represents an attempt to offer advice for the communication with the stakeholder in an atmosphere of requirements uncertainty and vagueness.

AWARE has been developed by the author of this thesis partly during the activity at TEC lab, the Technology Enhanced Communication Laboratory (www.tec-lab.ch) of the Faculty of Communication Sciences at the University of Lugano, partly during the visit at the department of Computer Science of the University of Toronto, and partly during the visit at the College of Computer Science at the North Carolina State University. The many-sided and fertile project-oriented research experience matured in these three contexts strongly contributed to conceive, bring forth and assess this work.

The scope of the results presented in this work is twofold. On one hand AWARE is aimed at moving a step forward in the research of communication design over the web and at suggesting concrete advances in the state of practice in web design. However, it is not at all intended as a definitive solution to all the issues concerning the activity of requirements analysis for web applications, which remains a complex and crucial task to be carefully addressed case by case. The research is already under refinement within the lab and further enhancements of the model are being under exploration and validation through parallel works.

On the other hand, the model presented is also addressed to professional web designers and analysts who would like to improve the quality of the outcome of the activity of requirements analysis. By drawing to this set of techniques, guidelines and tools for web requirements engineering, practitioners might find a support to their activity and incentives to shape more effective web applications.

1 Introduction

A proper way to understand an artefact is to discover its goal. This work arises from the interest of understanding the goals of a web application, i.e. to investigate as deeply as possible what guides and lies beneath the design decisions of web site development.

Over the last decade, there has been an explosion of literature on practical guidelines for shaping attractive web pages, for designing usable navigation architecture, and for editing properly the content for the web. Little attention has been paid to the activity of requirements and needs analysis, although it is widely acknowledged as a crucial success factor of a communication project. The goals underlying the design are worthy to be investigated because they are the central point around which the whole design activity should be concentrated.

In order to better explain the nature and the motivation of this thesis, the next paragraphs of this chapter are devoted to briefly illustrate the issues that inspired and contributed to conceive this work.

1.1 The Congruity of a Communication Artefact

The design of a web application should be not only correct in itself (e.g. consistent and complete) but, above all, it should meet the goals for which it has been conceived. Any communication artefact (and a web application can be considered a communication means) is properly designed if and only if it has the property of *congruity*, i.e. if it is compliant with the goals it should serve. For a web application, very general goals can be to enhance the user experience and, at the same time, to fulfil the objectives of the customers who built the application. Understanding the goals and the requirements is the preliminary step of any design process and the true quality of a design is mainly related to how well it matches the requirements.

For which purposes was a website designed? How do these objectives reflect onto the design choices? Who are the intended users of the site? Why should the potential users use the applications? Which goals might they want to accomplish? Investigating these and other similar questions can help reasoning with a first set of goals for the

website. Then, evaluating the congruity of a web application means – for example - to assess the degree of relevance of the content for the intended audience, the adequacy of the presentation of the content for the user, the feasibility of the user goals and the actual accomplishment of the goals owned by all the main stakeholders interested in the existence and in the success of the application.

The assumption of this thesis is that the evaluation of the congruity of a web site can be supported if the goals and the requirements of the site are properly taken into account throughout the development process. Paying attention to meeting requirements should be a "habit" of all the project team all along the lifecycle of the web application, from requirements analysis, to its promotion and maintenance.

Web design implies both art and rationality: that is the authentic creativity. Even if an impressive design solution for a web site is conceived, it should be somehow clear what is the problem it should solve, or the goal it should serve; only doing this, it is possible to evaluate the effectiveness of that solution and to consider design alternatives.

Within this framework of concerns, the main purpose of this thesis is to provide web designers and analysts with a goal-based conceptual and practical methodology that could help them conceive web applications that best correspond to their purposes.

The "congruity" problem can be seen as a specific aspect of a more general issue, both of theoretical and practical relevance: the relationship between the communication objectives (the "problems to be solved") and the tools for communication (the "solutions").

1.2 The Tension between Problems and Solutions

It is common experience that in different R&D communities, or even in the same community, the same words are used for addressing different things. This is the case of the words "requirements" and "design". It is not rare to find that what database designers call a requirement is actually a design solution for a hypermedia designer. What a hypermedia designer calls a requirement may be well seen as an implementation of a business plan by a marketing manager. Conversely, what a web designer calls design can be considered a set of requirements for a programmer. And what a programmer calls design a navigation architect can consider implementation.

Each professional or researcher, working from one point of the whole development process to another, considers as requirement what comes as input and as design solution what produces. Each actor in the project has a viewpoint [Leite, 1996], shaped by his

own experience, cultural background and project task, by which s/he tends to see preferably some aspects of a web application and neglects others.

Thus, it should be no surprise that web site development, where different professional figures (marketing mangers, communication experts, graphic designers, software engineers, content editors) need to work side by side throughout all the process, makes the need for an agreement between requirements and design more critical.

We may consider the word “requirement” as referring to the set of the problems to be solved and the word “design” to the set of “solutions”; however, this seems just a way to shift the problem from technical terms to common terms. The statement of a problem and the consequent discovering of a design solution should ideally guide the design process. As solutions are devised for problems that are not properly identified, solutions risk being wrong and needing hard interventions. However, that does not always happen. Partial and tentative solutions often help clarify the problem [Lowe, 2003], and this iterative discovery process may lead the whole development.

Once solutions have been defined, the reasons behind them should be documented. During the work with design teams and with students at their first design experience, it often surfaced a great difficulty to identify the “why” of the design choices. When asked “why” a piece of content has been designed, typical answers are: “it is very important”, “it cannot miss” or “these other sites do that”. In the best case scenarios, designers answer with a simple tautology: this content has been made available to provide the users with this content. It is as they claim to have a proper solution to an unknown problem. Questions about the reason of web design decisions are often overlooked. Only when designers begin to realize that few (or much less than expected) users come to the site and are happy with it, or the customer does not like the proposed design solution, these questions become tremendously relevant and urge an immediate answer.

One of the reasons of this “illness” of web design can be traced back to the easiness and the cost-effectiveness with which content can be edited and posted on the web. Once major design decisions on navigation and lay-out are taken, even content editors with little technological background can publish web pages and load online databases, thus increasing the information available on-line that nobody will likely consume. Unfortunately, whilst it is cheap to put information on line, it may be very costly to manage and update the content produced.

For these reasons, the activity of requirements analysis emerged as crucial also in web application development. How can less-experienced designers be supported in properly identifying and analyzing the goals of a web site? How can they be helped to shape a design meeting those goals?

In this thesis, we refer to requirements as the input for the conceptual web design activity, so as it is understood by the hypermedia research community. Web conceptual design is intended as the design of the user experience, i.e. the specification of the features of the web application in term of the detailed information, navigation, and transactional architecture shaping the interaction experience on the site. Requirements should provide a suitable input to make these decisions.

1.3 Discipline to Master the Complexity

Web sites today are growing more and more in complexity, both in size and in service sophistication. As Garrett states [Garrett, 2002]: “the web was originally conceived as a hypertextual information space; but the development of increasingly sophisticated front- and back-end technologies has fostered its use as a remote software interface”. For this dual nature, the design and the development of websites tend to borrow design approaches, methodologies, practices and techniques from the long-standing tradition of software systems engineering. Again, in a multidisciplinary design team, it may happen to find people that stress the software aspect of the site as most relevant and other that focus on the communication, hypertextual aspect as most relevant.

The communication requirements characterising a website are receiving some attention only recently [vanDerGeest, 2001]. By paying attention to the communication aspects means to consider the needs of the target audience of the site and the communication goals of the stakeholders as the fundamental drivers of the whole development process.

The approach adopted in this thesis focuses on the requirements analysis for communication-oriented web applications, i.e. those websites conceived first and foremost as means for a variety of stakeholders to communicate content and messages to a variety of target audiences. Moving from this fundamental statement, the work tries to devise paths for extending current methods in RE and discover the distinctive features of the requirements analysis activity for web applications.

1.4 Research Questions

This thesis focusses on the analysis and organization of requirements for web applications. One basic research question is addressed:

- How may analysts be supported in mastering the requirements analysis for websites?

Detailing this general question, two more specific concerns are investigated:

- What are the conceptual tools that may be provided to analysts to effectively negotiate, communicate, and specify requirements for communication-intensive websites, taking into account the spectrum of stakeholders involved?

- How may the outcome of the requirements analysis be effectively used for the conceptual design and usability evaluation?

The research scope of this work is constrained by two dimensions: the activity of the development cycle and the family of applications at issue. This thesis is not on requirements engineering in general, but on the activity of requirements analysis, which is an important – but not exhaustive – part of requirements management. Moreover, this work does not treat requirements analysis for information systems in general, but for content-intensive web applications characterised by communication objectives.

1.5 Research Method

This research has been conducted through two parallel and intertwined processes. On one hand, an analysis has been carried out as to the capability of the current requirements engineering frameworks to cope with requirements for web applications, and, in particular, with the requirements needed to shape an effective user experience in hypermedia-intensive environments. As a result, limitations and potentials of the studied approaches have been identified, and extensions to the current requirements models have been defined for tailoring them to the web domain. As this top-down method proceeded, the features identified for coping with web application requirements converged to defining a new model (AWARE).

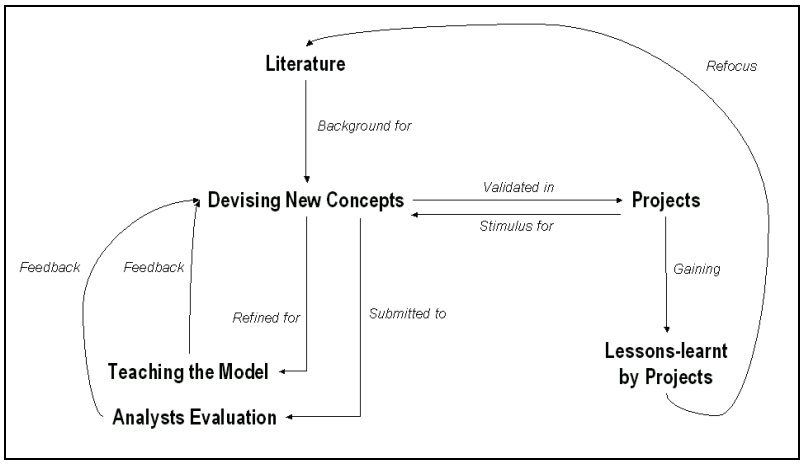


Figure 1. Overview of the research method.

On the other hand, the described process was stimulated, supported and led by an empirical work on real web projects. The experienced gained in these projects (some of them are reported in ANNEX II) allowed to strengthen, consolidate, refine and validate the features of the model as they became available. Applying the features of the model to real projects, and having other analysts try to use them, provided input for improving AWARE. Besides, project work was also accompanied by a continuous gathering of feedback from analysts, students, web designers and researchers. Activities such as publishing the results of the work, training professionals, and conducting limited surveys also supported the refinement of the model. This bottom-up approach enabled a continuous reflection on the project practice, and paved the way for future validations of the model.

1.6 Overview of Remaining Chapters

The rest of the thesis is organized as follows. Chapter 2 presents a review of the related work, highlighting key achievements relevant for this research in the field of requirements engineering, communication studies, human-computer interaction, information systems, and web design. As a result, this chapter will point out lacks of the current approaches to requirements management in coping with the issues relevant for web application requirements.

Chapter 3 presents the AWARE model, illustrating the key conceptual constructs and their use, with the support of application examples. The sequence in which concepts are described is not intended to indicate a process to be followed in the requirements analysis. They have been rather organized to facilitate the comprehension of the AWARE toolset. It is shown how the outcome of the requirements analysis conducted with AWARE may be tied up with conceptual design in a coherent fashion. Finally, proper indications to reuse the requirements knowledge for the usability evaluation of the site are illustrated.

Chapter 4 offers an overview of the method and results of the initial empirical validation of AWARE. The validation was carried out within the EU-funded UWA project (IST-2000-25131) and it is intended to be a first step in the assessment of how AWARE may be perceived and used by practitioners.

The conclusions, that summarize the novelty introduced by AWARE, are presented in Chapter 5. Benefits and downsides of the proposal are also briefly discussed.

Some outlooks for future work emerging from the current state of the art of the model are discussed in Chapter 6. Research action will focus on the further validation of the model, on the proper packaging and delivering of the AWARE toolset to web practitioners, and on the ongoing enhancements of the features of the approach.

ANNEX I proposes the primitives for a graphical notation of AWARE; ANNEX II illustrated the application of AWARE on real industrial and research web projects. ANNEX III contains a glossary to facilitate the consultation of the main concepts of the model.

2 Review of Related Work

This section is aimed at highlighting the salient contributions coming from a variety of research fields that served as basis for the development of AWARE, a model for the requirements analysis for web applications.

It should be not surprising that inputs from different disciplines are needed in order to cope with the problem of requirements for web sites. In fact, conceiving and building a web application carries with it competencies both in software engineering and in communication design: usability, interface design, navigation and interaction architecture, hypermedia and content design, graphic design, are just some of the disciplines that run together into web site development.

Moreover, leading authors of the research fields presented in this background section acknowledge that dealing with requirements needs a range of diverse competences such as psychology, sociology, and communication. Thus, domain knowledge, design and project management skills are not enough. This is due to the fact that understanding and interpreting human goals is a complex task, which can be hardly delegated to automatic procedures.

As shown in Figure 2, the results that are held as essential and interesting to this work emerged from five fields: Verbal Communication Studies, RE, Human-Computer Interaction (hereafter HCI), Information Systems, and Hypermedia modelling and design.

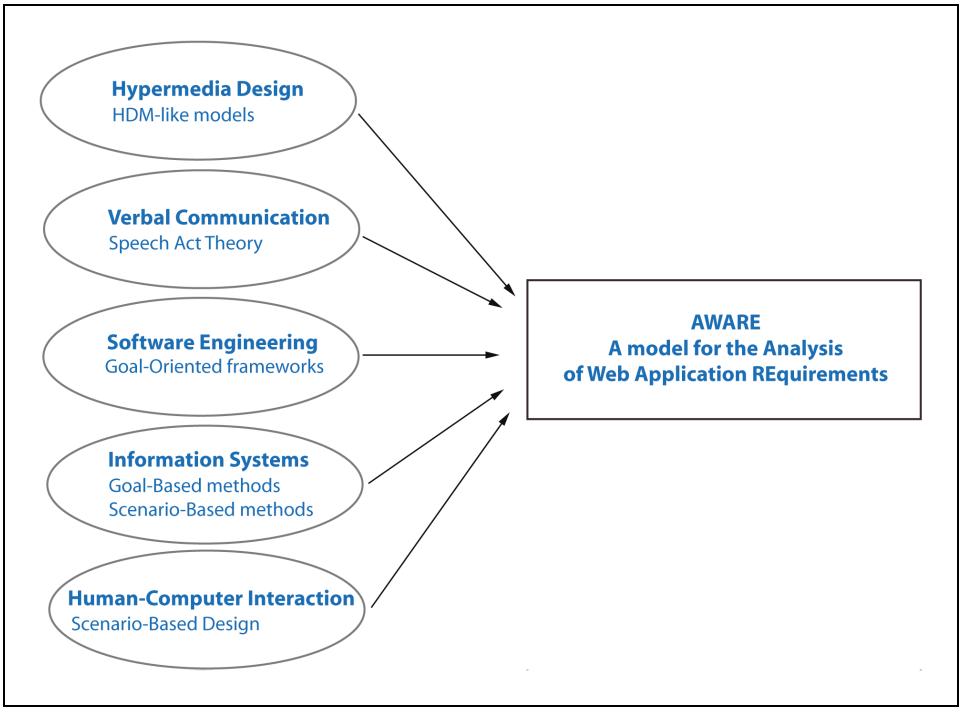


Figure 2: The composition of the background.

It goes without saying that this survey of related literature is not intended to cover all the achievements concerning requirements analysis. This task would be not relevant to this work and impossible for lack of space. Just the relevant models and conceptual tools identified as crucial background for defining a requirements analysis model *specific* for web applications will be discussed.

2.1 A Communication Perspective on Requirements

Some basic concepts of the Speech Act theory can help introduce the conceptual framework of this thesis.

In his book *How to do things with words* [Austin, 1962], John Austin investigates the structure of everyday language and the things we typically perform when speaking. Austin distinguishes three basic kinds of speech acts: *locutionary act* (what we say), *illocutionary act* (what we mean when we say it) and *perlocutionary act* (what we accomplish by saying it).

The locutionary act is the simple act of *saying* something meaningful, such as “100% of our customers are fully satisfied with this product”. Instead, the force of the

illocutionary act is the employment of this language for some *purpose*. For example, with the sentence "Your money will be refunded by one week after the purchase" one typically performs the illocutionary act of making a promise. Finally, the perlocutionary act is the speech act of having an *effect* on those who hear a meaningful utterance. For example, by illustrating the satisfaction of many customers, the client will be persuaded (or not) by the salesman to buy that product.

This distinction originally applies to human communication, namely to verbal communication. However, it might apply as well to the analysis of an advertising message, a movie or a web site.

Let us consider the communication scenario of modern web applications. Recent studies in the field of web communication analysis [vanDerGeest, 2001] [Cantoni, 2003] [Cantoni, 2001a] tend to consider a website as a four-party team comprising the following elements:

a) content, services, possible activities and interactions;
b) people communicating and offering (a) to clients;
c) clients accessing (a);
d) tools (interface, software equipment) available to clients to access (a).

In this general scenario, the people managing the website perform a *locutionary act* through this electronic communication means. In fact, they communicate content and services to their users. Web design is the activity by which communication solutions are shaped and conveyed.

Content and services are communicated for a purpose, being it the promotion of the corporate brand, the increase of the market share, the increase of the sales, the education of the audience or the support to specific users' tasks. Therefore, people managing the website perform an *illocutionary act* with respect to their audience: they wish to achieve the goals for which the web site has been designed. Web requirements analysis is the activity of defining the goals of the web site with respect to all the relevant stakeholders and providing input for the design.

The primary effect of the communication through the web site is how users actually use the web site. The *perlocutionary act* corresponds to the actual usage of the site. The analysis of the perlocution concerns the usability evaluation, which aims at assessing how effectively users accomplish their goals on the site and what are the effects of the design choices on the user experience.

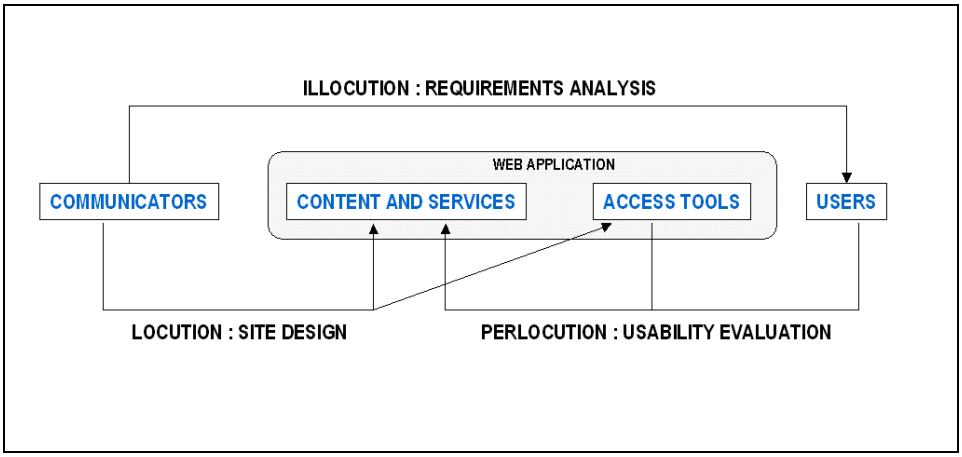


Figure 3. Web Communication Acts

Figure 3 shows the correspondence between the speech acts (reinterpreted as web communication acts) and some key activities of web site management process. Communicators are the stakeholders who conceive the site to communicate messages and offering services to the users. Illocution is addressed primarily to the user because a crucial activity of requirements analysis is to understand the goals, needs, preferences and expectations of the users (the so called “user requirements”).

Locution is primarily focussed on the application itself: according to the requirements identified, messages have to be shaped in a suitable manner and the site structure (access tools) has to be designed. Over the last decade, practitioners and researchers defined a large and heterogeneous set of design techniques for web applications.

Perlocution concerns primarily the users and the evaluation of their experience with the application (usability). In HCI field, a specific technique seems to fit the analysis of perlocution: usability claim analysis. Claim analysis [Carroll, 2000] consists in stating claims about potential causal relationships between features of the design and consequence for the user experience. This technique help designers to consider both positive and negative consequences of the design on the user; questions about how the design suggests a course of action or support user tasks are discussed. Claims are defined at design time, because designers need to fix negative claims (i.e. negative envisioned effects on the user) as early as possible.

This section pointed out the analogy between speech acts and some key activities in the development process of a web site intended as communication means. This thesis primarily concerns the requirements analysis for web applications (*illocution*); however,

proper bridges from requirements to conceptual design (*locution*) and to usability evaluation (*perlocution*) will be provided not to loose the overall picture of the web communication process.

2.2 Goal-Oriented Requirements Engineering

2.2.1 The Activities of Requirements Engineering

The activity of requirements analysis has been deeply studied in the field of RE. In this research area, a considerable body of knowledge on methodologies and practices for managing requirements for software systems has been developed in the last decade.

RE covers a wide spectrum of activities; thus, it is difficult to state one comprehensive definition of what RE is. However, one of the clearest definitions seems to be the one given by Zave:

"Requirements engineering is the branch of software engineering concerned with the real-world goals for, functions of, and constraints on software systems. It is also concerned with the relationship of these factors to precise specifications of software behaviour, and to their evolution over time and across software families" [Zave, 1997].

This definition helps to understand two important aspects of RE: a) the centrality of the goals of the systems and of all relevant stakeholders; b) passing from these goals to the specification of the corresponding system is a core RE task.

The expression Requirements Management is often used in the literature as an easier-to-understand synonymous of Requirements Engineering. Requirements Management identifies a set of activity carried out *all along the development process*. Requirements Management is not only a set of skills, techniques, or methods, but also a *habit* towards the system being envisioned.

In general, requirements management involves a set of interrelated tasks, which can be summarized as follows [vanLamsweerde, 2000]:

a) *Elicitation* consists in grasping, make surface, learning, negotiating and gather the requirements by the relevant stakeholders;

b) A*nalysis* means deciding which requirements to solve (also called *triage* [Davis, 2002a]), prioritising them and defining the general strategy to solve them, so to provide input to design.

c) S*pecification* is the activity of documenting requirements to communicate them in a suitable way to stakeholders and designers.

d) V*alidation* aims at assessing the quality of the requirements and agreeing (if necessary re-negotiating) on requirements with the stakeholders.

These activities are usually intended to be carried out iteratively and incrementally all along the development process.

2.2.2 The Goal-Oriented Revolution

Taking into account the intertwined activities of the requirements management process, a more technical - but more complete – definition of RE is provided by van Lamsweerde [vanLamsweerde, 2000]:

"Requirements engineering is concerned with the identification of the goals to be achieved by the envisioned system, the operationalization of such goals into services and constraints, and the assignment of responsibilities for the resulting requirements to agents such as humans, devices and software".

This definition stresses even more the central role of the *goals* to define proper requirements of the system.

A *goal-oriented approach* to requirements is a quite recent achievement in RE [Dardenne, 1991][Dardenne, 1993][Mylopoulos, 1999], and it represents an important shift of paradigm in the way to look at the definition of requirements.

In time when most of the attention was paid to data specification and operation requirements, almost without wondering *why* those requirements were there and were worthy to be taken into account, a goal-directed approach pointed out the need of defining and analyzing the reasons and the ultimate objectives of the requirements specifications. Actually, requirements and design specification languages from SADT [Ross, 1977] to UML [Jacobson, 1999] do not provide specific constructs to analysing and dealing with goal models.

The main critique that the supporters of goal-based methodologies move to previous approaches was that requirements were supposed just "to be there" [Dardenne, 1991]. Requirements focused only on what the system is supposed to do. Goal-driven approaches claim that understanding the goals behind the requirements is a mean to enhance the requirements quality and, consequently, the effectiveness of system design.

Before the “goal-oriented revolution”, the research effort in RE was focused on “the what-how range” [vanLamsweerde, 2000]. Requirements analysis was considered as the activity of describing what functionality the system should provide. Introducing the identification and the analysis of the goals meant to point out the rationality of the design process, paving the ground for a better system design.

A goal-directed philosophy to system design was borrowed from the Artificial Intelligence (AI) domain, where goals have been studied since ‘50s, mostly as part of formal frameworks modelling agent planning.

2.2.3 The Benefits of Goal-Directed Reasoning

Today, the notion of goal is increasingly being used in RE. Maybe for this reason, it is difficult to discern a uniform notion of goal in requirements analysis methodologies. However, the importance, the benefits and the usefulness of *goal-based reasoning* for application design can be devised under several respects [Yu, 1998].

2.2.3.1 Acquiring Requirements

The identification of goals helps to lead to the repeated asking of "why", "how" and "how else" questions. Requirements of a stakeholder are often revealed in the process of elaborating and refining a goal. Stakeholders also become more aware of potential alternatives for fulfilling their goals, and are therefore less likely to trespass to premature design or technological solutions.

2.2.3.2 Relating Requirements to Organizational Context

As stated in [Yu, 1998] “*[software] systems are [increasingly] seen as providing solutions to business and organizational problems; the relationship between systems and their environments are being expressed in terms of goal-based relationships*”. The notion of goal helps to understand and express the real world needs the software system is aimed at satisfying. These real-world needs are surrounded by a number of context properties, such as organizational policies, law restrictions, or business objectives, which have to be somehow taken into account in order to understand what goals the system should fulfil and what constraints it should respect. In this complexity, goals serve as bridge between the real-world needs and the development process.

2.2.3.3 Clarifying Requirements

Often, initial requirements are unclear when elicited for a number of reasons: they may be too complex and cryptic, or expressed in an improper way, or may be vague and imprecise. Goal analysis allows elaborating and pruning goals that clarify the nature of requirements and highlight their complexity.

2.2.3.4 Allowing Traceability of Rationales

Goal-directed analysis allows keeping traces of the choices taken about requirements by highlighting the reasons for which certain requirements have been defined. In this way, the motivations behind the decisions about requirements are clearly documented and explicit. Keeping track of the rationality of requirements definition by means of goal analysis may support both *backward traceability* and *forward traceability*. Backward traceability allows seeing to which requirements and to which goals a design artefact is a possible solution. Forward traceability allows following the evolution of a goal from its definition to the design artefacts on which it has an impact. In other words, backward traceability explores the *continuum* from design to requirements; forward traceability explores the *continuum* from requirements to design.

2.2.3.5 Dealing with Conflicting Viewpoints

The problem of conflicting requirements is a well-known issue in RE. Stakeholders may have different viewpoints on the systems and conflicting interests [Leite, 1996]. Goal-based methodologies devised diverse strategies for handling conflicts between requirements. In general, it can be said that a goal-based approach allows uncovering the nature of the conflict in the intentions (i.e. in the goals) that generated those problematic requirements.

A further problem is usually that conflicting requirements are discovered at the later stages of the analysis, when design activities have already begun**.** A careful and previous goal-analysis allows discovering and managing conflicts early in the analysis process during the elaboration of goals and their refinement into operational requirements.

2.2.3.6 Exploring Design Alternatives

Reasoning with goals of the stakeholders allows exploring different possible solutions for satisfying the goals. Design alternatives can be evaluated on the basis of their relevance, resources needed and effectiveness. Alternatives are discussed and, eventually, discarded or kept. The exploration of alternative designs is essential to avoid that the creativity ossifies on just one envisioned solution before having considered different means for achieving the same goals.

2.2.3.7 Enhancing the Validation

Goal analysis facilitates the evaluation of the quality of the application under construction. In fact, the "congruity" of the system (see paragraph 1.1) – which assesses the most important quality of the application - can be verified by checking the correspondence of the running system with the goals stated in the requirements analysis. If this match works fine, then the intrinsic quality of the application is achieved, because it corresponds to the objectives contracted. Otherwise, the system – even if it works correctly – might not be useful to the purposes it was conceived and designed. In this case, incongruities between the goals and the working system should be detected and something *must* be eventually changed. Thus, goal-based evaluation does not only check correctness, i.e. compliance with low-level requirements, but rather congruity, i.e. correspondence to the ultimate and long-term goals of the system.

2.2.3.8 Managing Change

Requirements may evolve and change over time for a variety of reasons: clients and main stakeholders decide to address different and more sophisticated needs; they discover that new goals are of interest, or the technological environment open new operational opportunities. Through a goal-based analysis, changing conditions can be formalized into new goals, while some previous goals may be removed or modified. At this point, a new requirements analysis - focused on the changed goals - is needed in order to understand the new solution space; then the consequent new design the system must be shaped upon is devised. As such, interpreting the changing variables at the goal level can facilitate meeting changing requirements.

2.2.3.9 Supporting Reuse

Defining goals and then stating traceable links to the requirements and then to design provide the development team with a great potential for reuse. Conceptual reuse

at a high-level of abstraction is made possible by a goal-directed approach. In fact, it is possible to capitalize on the effort in understanding and documenting goals (which is often a costly and hard work), and that could be exported (with proper adaptation) to similar applications. Analysts can reuse pieces of the goal analysis, where the decomposition of a goal into sub-goals and then into requirements is documented. Requirements patterns [Ferdinandi, 2001] can be identified and might serve as a valuable means to share requirements experience within the organization.

Among the Goal-Oriented RE frameworks, two methodologies are the most assessed, at least in the R&D arena: a *formal* one, known in the literature as KAOS; and a *qualitative* one, known as the NFR methodology.

2.2.4 The KAOS Methodology

KAOS (Knowledge Acquisition in autOmated Specification [Dardenne, 1993]) is the first formal requirements analysis framework based on a goal-oriented approach. It was developed by Axel van Lamsweerde and his group at the University of Louvain, Belgium, in the early 90's.

Basically, KAOS provides support for:

a) acquiring, specifying and analyzing system goals for large software applications;
b) deriving the corresponding requirements;
c) assigning responsibilities for the satisfaction of the requirements in the system specification.

System goals are considered high-level objectives of the system and are classified according to five patterns: *Achieve*, *Cease*, *Maintain*, *Avoid*, *Optimize*. For example, in a library information system managing the borrowing of the books, system goals may be: *Achieve Borrower Request Satisfied*, *Maintain Borrower Privacy*, *Optimize System Resources, etc.*. Goals are defined with a precise semantic expressed in a temporal first order logic[1] to remove ambiguity and consequent misunderstandings that may arise during the analysis process. According to the authors of KAOS, modelling goals with formal logic facilitates consistency checking and detection of possible conflicts early in

[1] Temporal operators such as "current or some future state, "current and all future states, "next state", "previous state", or "current or some previous state" are added to traditional first order logic constructs.

the analysis. Goals are refined into subgoals and eventually progressively reduced ("operationalized") into system *constraints* or *agents*. This refinement process is expressed through AND/OR relationships. Tactics and principles for refining goals in an effective way are suggested. Thanks to this toolset, KAOS brings about the analysis from system goals to detailed system specification, documenting traceability all along the analysis.

One of the major benefits of KAOS is that it introduced systematically a goal-oriented paradigm in RE, defining general concepts to be taken into account for passing from goals to requirements specification.

However, KAOS addresses software systems with a strong focus on system goals and requirements, providing little support for capturing and analyzing high-level and ill-defined stakeholders' goals (including users' goals). Examples of the use of KAOS do not show its effectiveness in modelling requirements for interactive applications, where interaction, communication and user requirements play a major role. Due to the formalism required to carry out goal analysis, KAOS may also be difficult to be readily applied for web designers without an engineering background.

2.2.5 Non-functional Requirements (NFRs) and TROPOS

A distinction shared in the RE community is the difference between *functional* and *non-functional requirements*. Functional requirements describe the behavioural aspects of the system, i.e. the desired functionalities, operation and data the system should provide. Examples of functional requirements are all the descriptions of the services and features the system. Non-functional requirements describe instead the non-behavioural aspects, i.e. the quality attributes of the system. Examples of non-functional requirements are general system properties such as usability, security, trustworthiness, ergonomics, flexibility, reliability, or scalability [Chung, 2000].

The NFR (Non-Functional Requirements) framework provides a goal-oriented model for the analysis of non-functional requirements of software systems. For this reason, it is also known as a *qualitative* framework. NFR was developed starting from the seminal work by Mylopoulos et al. [Mylopoulos, 1992] with the aim of responding to the need of representing and taking into account systematically non-functional requirements in requirements analysis and system design.

One of the key concepts of NFR is the notion of *softgoal*. Softgoals are goals that do not have a clear-cut criterion for their satisfaction [Mylopoulos, 1999]. This construct allows representing goals concerning non-functional requirements as well as ill-defined

and high-level objectives of the stakeholders. For example, some softgoals of the managers of an electronic bookstore might be: *increase market share*, *make customer happy*, *provide a usable interface*, *keep a large assortment* [Castro, 2002]. While the goals treated in KAOS may eventually be reduced into a set of system operations, softgoals instead are not simply satisfied by the specification of the system behaviour. For this reason, some authors [Mylopoulos, 1999] distinguish between *satisfying* a goal and *satisficing* a goal. While *satisfying* a goal implies a mechanic translation of a goal into an operative behaviour, *satisficing* a goal suggests the indefiniteness of the relationship goal-requirement, and points out the risk of doing a strategic decision that might contribute to fulfil an objective. Softgoals are satisfied when there is *sufficient* positive evidence for their satisfaction; otherwise, they are not satisfied. When there is conflicting evidence for the satisfaction of a goal, the decision has to be taken interactively in the negotiation with the stakeholders.

NFR analysis allows thus to consider a broader set of goals, that were *de facto* excluded by KAOS, which analysed only those goals that are precisely-defined and may be "operationalized" with a formal derivation process. Moreover, softgoals may be expressed informally (for example, in natural language), so to allow the stakeholders to understand and reason with goal analysis.

On the basis of the NFR framework, a systematic methodology named TROPOS[2] has been developed, which aims at modelling early requirements and reasoning with goals for information systems. To this end, TROPOS adopts the *i** notation [Yu, 1993] which offers the notions of *actor*, *goal*, *softgoal* and actor *dependency*.

According to *i**, actors – which represent the relevant project stakeholders – often depend on other actors to satisfy their goals and softgoals. In the e-bookstore example, the actor "*shop manager*" depends on the actual purchases made by the online users to satisfy the goal "*increase market share*". *i** explicitly models intentional[3] and dependency relationships between actors. Dependency relationships give reason of the fact that, while goals are relative to a stakeholder, the fulfilment of the goals is often collaborative, for it requires other actors to come into play. Dependencies may also involve other factors, such as tasks or resources needed to accomplish goals.

Besides AND/OR refinement relationships (used by KAOS), *i** employs new types of relationships between goals.

[2] Comprehensive information about the TROPOS project can be found at the official web site: http://www.cs.toronto.edu/km/tropos/

[3] "*i*" of *i** (pron. I-star) suggests the concept of distributed intentionality.

A goal/softgoal can partly *contribute positively* or *negatively* to the satisfaction of an upper goal/softgoal. Moreover, a goal can *prevent, influence, make possible, hurt* and *break* the satisfaction of another goal. For example, in the requirements specification of an office automation system [Mylopoulos, 1999], the softgoal *access to database* contributes negatively to the satisfaction of the *maintain security*; whilst *maintain security* contributes negatively to the achievement of *achieve flexible work pattern*. *Usability* softgoal, on the other hand, contributes positively to the satisfaction of the softgoal *sharing information*.

As such, *i** goal analysis emphasizes soft and ill-defined relationships that may capture complex aspects of the real-world environment (called early-requirements). The *i** process ends when goals and soft-goals have been analysed and leaf nodes of the goal graph are selected as the input for the software design activity.

NFR and TROPOS seem to take into account most of the complexity of the analysis which KAOS seems to overlook. *i** points out that the refinement process from goal to refinement is not necessarily a straightforward decomposition but the result of a continuing interplay between estimation of resources available, verification of the feasibility of goals, considerations of the intentions of the stakeholders, trade-offs among competing constraints, negotiations and human decisions.

2.2.6 UML Use Cases

UML (the Unified Modelling Language) “is a graphical language for visualizing, specifying, constructing, and documenting the artefacts of a software-intensive system” [OMG, 2001]. UML was initially conceived by Booch, Rambaugh and Jacobson as the unification of different object-oriented analysis and design methods of late 80s and early 90s. Today, UML is increasingly considered as the current industrial standard notation for software modelling and specification.

Among the large set of constructs offered by UML, *use cases* are often advocated as a key conceptual tool to specify software requirements. However, in the requirement engineering community, there are diverging views on the effectiveness of UML and use cases in supporting requirements [Glinz, 2000][Sutcliffe, 2002].

In [OMG, 2001], a use case is defined as “a classifier representing a coherent unit of functionality provided by a system [...] as manifested by sequences of messages exchanged among the system [...] and one or more outside interactors (called actors)”.

A use case diagram basically represents two kinds of entities: *actors* and *use cases* performed by one or more actors. The next two paragraphs will discuss the notion of

UML actor and use cases in comparison with the needs and claims of a comprehensive goal-oriented approach to requirements management.

2.2.6.1 Actors and Stakeholders

UML actors model anything (object or subject) interacting with the system [Cockburn, 2000]. Quoting from one of the OMG definitions [OMG, 2001], "an actor defines a coherent set of roles that users of an entity can play when interacting with the entity".

Besides users, goal-based requirements analysis needs also to model other stakeholders who have goals with respect to the application. Actually, some stakeholders are not necessarily interacting with the system. There are stakeholders who state objectives for the systems, claims for requirements to be fulfilled and nurture expectations with respect to application.

For example, the requirements analysis of a web-based university course should surely take into account the students' tasks and expectations but, above all, the learning goals of the instructor and their requirements for the course design. In this case, the instructors are key stakeholders to be considered, even if they will probably never interact with the final application as users and therefore could not be modelled as UML actors.

In other words, requirements analysis should be more than *user-centred*; it has to be *stakeholder-centred*, in the sense that all stakeholders (users included) should be possibly satisfied. Business and communication objectives need to be fulfilled as well as users goals. Evidently UML actors do not cover the whole spectrum of stakeholders to be considered in the requirement analysis because they consider *only* the user side of the requirements picture.

Finally, it should be noted that the notion of *actor* in UML even differs from the one used in *i** (see 2.2.5). Use case actors are system "interactors" (users). *i** actors are stakeholders in general (who may included users).

2.2.6.2 Use Cases and Goals

UML use cases define units of system functionality carried out by one or more actors. Example of use cases performed by a bank operator using the bank information system might be: *Insert Customer Data, Establish Credit, Place Order, Check Customer Status*. Use cases do not presuppose any sequence or order between the actions described

by a use case diagram. However, it is possible to give a certain structure to the use case diagrams; for example, a use case can include or be connected other use cases.

Use cases claim to capture user interactions. They represent a dynamic view of the system; as such, the walkthrough in a use case is often used as a structured and detailed *scenario* [Cockburn, 2000](see 2.3). With use cases, analysts may model operative tasks of envisioned users that will be eventually mapped to system functionality.

Unlike detailed task analysis, goal analysis needs to express wished state of affairs in the real world and also explore alternatives strategic solutions for the system design. It does not necessarily describe functional interaction between the user and the system.

As such, use cases do not seem to be the most suitable tool for modelling high-level and ill-defined users' goals, which are very relevant for the design of electronic communication means like most web sites are.

For example, let us consider a student wishing to graduate from communication science but having not yet decided which university to attend. The goals this student might have in mind when visiting the web site of one of the potential target universities (abroad) might be the following:

- *decide if the school of communication science of university X is worth attending;*
- *understand the key success factors of the school;*
- *compare the benefits offered by the university with respect to other universities in the same geographical area;*
- *be convinced of the quality of the faculty members;*
- *figure out the documentation process a foreign student has to go through in order to enrol and to live in that country*.

These cannot be considered "units of system functionality"[OMG, 2001], but rather user goals. If analysts would like to capture and reason with these goals, they would need conceptual tools different from use cases. For this reason, goal-graph used in goal-oriented models like KAOS and *i** are structurally different from use cases and cannot be reduced to use case diagrams.

We can summarize the comparison between use case-based approach and a goal-based approach to requirements analysis as follows. Goal-based approaches may capture and analyse the goals of the stakeholders that are not necessarily end users. Moreover, goal models tend to deal with a higher level of abstraction than use cases.

2.3 Scenarios in HCI

A user scenario is a description of an episode of use of the application.

Scenario-based approaches have been originally developed in HCI field in the late 1980s, but they are now recognised as an important conceptual tool for RE, new media design and strategic management. Today, scenarios are a widely used technique for supporting the requirements analysis, design and evaluation of interactive systems. Being a general and interdisciplinary concept, there have been many attempts in defining what a scenario is or should be. A definition that might be useful for the scope of our work is the following [Jarke, 1998]:

A scenario is description of the world, in a context and for a purpose, focusing on task interaction. It is intended as a means of communication among stakeholders, and to constrain requirements engineering from one or more viewpoints (usually not complete, not consistent, and not formal) [Jarke, 1998].

According to Carroll [Carroll, 2000], five key properties of scenarios motivate their widespread use[4]:

1. Scenarios focus on *use*. Descriptions of *use* stimulate designers to reflect upon concrete circumstances of interaction.
2. Scenarios enable *concrete progress* but *suspend commitment*. On one hand, they allow specifying and exploring design alternatives; on the other hand they are rough, incomplete, and easy to change.
3. Scenarios are *task-oriented* and can be used for *many purposes*. The focus on tasks lends itself to be effectively employed during analysis, design specification, usability evaluation, and for documenting design rationale.
4. Scenarios capture knowledge as a *middle-level abstraction*. They are more concrete than formal models but more reusable and flexible than the recording of a user experience.
5. Finally, scenarios are *easy to understand* by all stakeholders. Designers, users, analysts, project managers and customers can all "speak" the language of scenarios because narratives are privileged cognitive structures.

Scenarios are also defined as "*stories about use*" [Carroll, 2000], because they are usually expressed in narrative form and may focus on different aspects of the user experience [Jarke, 1998].

[4] For a cognitive perspective on scenarios, grounding principles of cognitive psychology that explain the effectiveness of scenarios are explained in [Jarke, 1998].

For example, scenarios may focus on the *interaction (a)*, vividly representing a user performing a specific sequence of tasks with the application.

Scenarios may also focus on *context (b)*, describing examples of user motivations and goals within the environment (intentional, physical or social context).

Finally, scenarios may also focus on the *interplay of system components (c)*, highlighting how processes and information flows are carried out within the system under particular conditions.

The scopes described are not intended to be exclusive or used alternatively. In fact, a scenario can cover all three scopes; however, for the specific needs of a stakeholder-centred requirements analysis for web applications, relevant kinds scenarios are *a)* and *b)*.

The envisioned users, which play a major role in a scenario, may also be described at different levels of abstraction. On one hand, high-level general descriptions of user profiles can be stated according to a variety of variables, such as socio-demographic factors or level of knowledge of the application. On the other hand, specific descriptions of concrete individuals (also called *personas* [Cooper, 2001] [Garrett, 2002]) can also be used as vivid representations of archetype users.

In RE, scenarios are considered extremely useful to support the management of requirements under several respects.

They help in the elicitation of requirements. Soliciting stakeholders to envision success stories of use of the application can help surface requirements and uncover hidden goals. Potential users can also be asked to discuss and elaborate wished scenarios of use in order to grasp their expectations and preferences.

Scenarios may effectively be couple with goal-driven requirements analysis [Rolland, 1999]. The use of scenarios complements goal modelling because, whereas goals focus on abstractions that describe users' intentions, scenarios make abstract intentions clearer, by giving concrete examples of how the application might actually fulfil users' goals [Sutcliffe, 2002]. Users' goals are synthetic and abstract representations of targets of achievement. Scenarios exemplify goals owned by particular users in a particular context of use; they enrich the goal with useful details enabling to understand its relevance and rationale. Goals focus the selection of salient scenarios, but also conversely, scenarios enable goal discovery [Jarke, 1998].

Scenarios can enhance requirements specification too. In fact, due to their narrative, simple and intuitive structures, scenario-based descriptions are particularly effective to communicate stakeholders' goals and expectations through vivid examples of use. Stakeholders by means of scenarios can also share success stories of the application.

Scenarios are useful for design too, because they may surface application features to be designed and help making design decisions. Designing by-scenarios may help ensure that critical users' tasks are supported. A main drawback of the use of scenarios in isolation is that fact that they are partial descriptions of the system behaviour. They are examples of user experiences that do not usually cover the whole set of interactions supported by a design. Relying on scenario only for the requirements and design of complex applications may be risky: scenarios may be conflicting, partial, and inconsistent. Scenarios should be complemented by other design techniques, that might reconcile scenarios to obtain a consistent and complete set of requirements.

Scenarios are also widely used for evaluation in different stages of the lifecycle. Scenarios may validate the design, assessing its effectiveness in supporting specific users' goals and tasks. Performing scenarios on low-fidelity prototypes (e.g. paper mock-ups of the user interface) is useful to detect usability problems, highlight missing features or functionality to be changed. Once the application is deployed, scenario-based evaluation techniques can be used for the usability assessment of the final product.

2.4 GBRAM and Goals Identification

GBRAM (Goal-Based Requirements Analysis Method) [Antón, 1997] was defined with the aim of providing analysts with conceptual tools for carrying out an effective goal analysis for software-intensive information systems. Basically, GBRAM supports the identification of high-level goals from various sources (documents, interviews, business goals, transcripts, policies) and defines strategies for elaborating these goals into requirements for the system. The method identifies two intertwined macro-activities characterising this process: *Goal Analysis* and *Goal Refinement*.

Goal analysis consists in *exploring* the input sources available; goals are then *identified* by applying heuristics and techniques on this raw material. Finally, goals are systematically *organized* and classified in goal hierarchies highlighting dependencies.

Goal refinement consists in *pruning* the goals identified; in this process, the definition of *scenarios* – intended as "behavioural descriptions of the system and its environment" [Antón, 1997] – enables to detail goals, point out exceptional behaviors, consider obstacles for their achievement and surface hidden goals. Finally, goals are *operationalized* into requirements so to provide designers with document with the detailed requirements specification.

GBRAM addresses diverse aspects that are worth taking into account for the analysis of web application requirements.

Unlike KAOS, that mainly considers system goals, GBRAM explicitly models stakeholders' goals and, in particular, users' goals, focussing on the conceptual tools for *defining* goals from the existing project documentation. The user experience is particularly relevant for web-based services; as such, requirements analysis should pays particular attention to user requirements and goals and not only to system goals.

Goals in GBRAM are expressed in a lightweight and semi-formal representation. This allows relevant stakeholders to participate proactively in the analysis process. Moreover, easy-to-understand goal analysis lends itself to be used by analysts that are either less-experienced or do not have a computer science background.

GBRAM shows how effectively scenarios can be used to complement goal analysis. Scenarios enabled to capture aspects of the requirements that may be overlooked while reasoning with goals in isolation. In fact, they are used in GBRAM to discover unexpected usage patterns or exceptions in the system behaviour.

Moreover, in [Antón, 2001] [Antón, 2002], GBRAM successfully applied to software-intensive *web-based systems*. In this domain, the heuristics of the method are employed to extract goals from existing specifications, from design or text artefacts (*goal mining* techniques).

2.5 Hypermedia and Web Design Methods

Requirements analysis should provide an organized input to the design activity. As such, in order to understand requirements analysis for web applications, it is essential to understand current web design techniques, so as they are considered both by the researchers and by the practitioners.

Garrett observes that "most websites are not *designed*. They are, at best, *contrived*, that is roughly patched together using a mix of half-understood guidelines, imitations of approaches taken by other sites, and personal preferences masquerading as common sense" [Garrett, 2003]. As a consequence, the user experience is not planned, often making the web site unusable for the user and ineffective for the business.

In response to this lack of method, over the last decade, the hypermedia and web research community developed a number of models for systematic user-centred conceptual design of web applications. In general, these approaches share a main objective: provide concepts and notations to describe hypermedia features of complex web sites at the proper abstraction level (i.e. implementation-independent).

Most of the approaches to hypermedia design focussed for a long time on information and navigation modelling, in response to traditional software engineering approaches to design, which tend to focus exclusively on functionality. However, there have been recent attempts to integrate these two aspects (hypermedia and functionality) because a complex web site design requires that both aspects be taken into account.

Models like HDM [Garzotto, 1993], RMM [Isakowitz, 1995], OOHDM [Güell, 2000][Schwabe, 1998] and WebML [Ceri, 2002] are the archetypes of other design methodologies, such as EORM [Lange, 1994], WSDM [De Troyer, 1997], and the work by Lee [Lee, 1997]. Extensions of UML for hypermedia and the web [Baumeister, 1999] have also bee proposed. Assuming a given set of user and business requirements, these approaches basically enables to define:

a) the information conceptual schema of the web site; it enables to design the overall information architecture and the detailed the structure of the types of information objects;

b) the navigation schema: it shapes the navigational paths available to the user to locate, reach and explore the content of interest;

c) the presentation schema; these constructs usually allow to design the abstract interface and the logic structure of the page types (in term of graphics, layout and link labelling).

Models have also been defined to integrate site functionality (expressed in UML notation) in the overall hypermedia design [UWA, 2001c]. These approaches define operations and transactions available to the user and integrate them in the site design process.

Systematic approaches to web conceptual design are advocated to enhance the quality and the efficiency of design in large projects, mainly for two reasons. On one hand, separation of concerns helps the project team manage complexity; on the other hand, the definition of design patterns provide a basis for the reuse of effective practices across different projects [Paolini, 1999].

Design models enable designers to describe the design artefacts that represent somehow the outcome of design decisions.

Where do design decisions come from?

The problem of requirements analysis was not overlooked by the hypermedia community, although much emphasis was on design. Recalling an old practice of ancient rhetoric [Cantoni, 2001], and the requirements practice of journalism and traditional media, a simple checklist for requirements discovering is often used. It suggests investigating five basic lines of reasoning (called W5):

1. *Who* is interested in the application? This question leads to identify users and other stakeholders.
2. *Why* are they interested? This question addresses the exploration of the reasons for the users to use the applications and the reasons for the stakeholders to build it.
3. *What* can be provided to satisfy their needs? This question concerns the requirements for the content and services to be offered by the application.
4. *When* will the user access the application? This question explores scenarios highlighting typical contexts of use of the hypermedia, to frame the user tasks in his/her everyday work and activities.
5. *Where* will the user access the application? This question explores scenarios highlighting physical circumstances of use of the hypermedia, in order to identify user requirements concerning technical accessibility and time constraints.

Similar approaches - based on Ciceronian rhetorical principles - for addressing requirements, design and evaluation issues for websites have also been developed [Mich, 2003].

Web consultants and professional designers usually favor lightweight, prototype-oriented and flexible methods rather that structured, semi-formal, notation-oriented and prescriptive approaches. However, the basic principles informing the web and hypermedia design models defined by researchers were borrowed by practitioners in the web domain.

As a result, practitioners today recognize the need of understanding business and users' goals in order to shape web applications enhancing the user experience and meeting customer's objectives. On the basis of this awareness, several straightforward approaches to user-centred web development have been defined [Cato, 2001] [Brinck, 2002] [Garrett, 2002]. User requirements and tasks are defined on the basis of field research and scenario envisioning. Business goals are captured through focus groups, interviews and analysis of available documentation. On the basis of this requirement set, an information architecture matching user tasks and business objectives is sketched. Iteration between prototypes, evaluation and redefinition of requirements is carried out to ensure a quality product.

It is interesting to note that web practitioners points out very clearly the need of bridging tightly requirements, conceptual design and usability evaluation (issue that is often overlooked by the current research streams). However, in the everyday work of

web designers, the relationships between the definition of requirements and the conceptual design of the web application is often left to the creativity and intuition of the project members.

This dissertation is aimed at suggesting a tool to support systematically the process from requirements to conceptual design to improve the requirements quality. The strategy general adopted is to valorise the current practices and methods developed in RE and properly tailor them to the web domain.

2.6 Summary

This chapter provided an overview of the relevant background work for a goal-oriented perspective on requirements analysis. To summarize the contributions and pave the ground for the next steps, Table 1 compares the goal-oriented requirements approaches discussed in this chapter in regards to the relevant issues for web application requirements. This synopsis aims at highlighting the issues that each method addresses, paying particular attention to the following areas of requirements management: goal modelling, goal analysis and support for the web-specific aspects.

Support Offered for	Issues Addressed	Approach or method				
		Kaos	Tropos - *i**	Use Cases	Scenarios	GBRAM
Goal Modelling	User tasks	v	v	v	v	v
	User goals		v	v	v	v
▶	Ill-Defined Users Goals					
	Stakeholders' Goals		v			v
▶	Communication Goals					
	System Goals	v				v
Goal Analysis	Refinement Process	v	v			v
	Heuristics	v		v		v
	Informality		v	v	v	v
	Goal-Scenario coupling	v	v	v		v
Web Development ▶	Hypermedia requirements					
▶	Bridge to Web Design					
▶	Reuse for web usability				v	

Table 1. Synoptic comparison of main goal-based requirements approaches. Marked issues are particularly relevant for web applications.

For each area, specific issues are listed. Some issues are relevant to any goal-driven method and serve for pointing out some distinctive aspects of the methods presented. Other issues are instead considered specific for web applications. In particular, little support is provided for the following issues.

- *Ill-defined user goals* (see 2.2.6.2) are high-level objectives of the potential users that cannot be easily mapped to system operations.

- *Communication goals* (see 2.1) refer to the intentions of the stakeholders to communicate messages and contents to a variety of audiences.
- *Hypermedia-specific requirements* are requirements having an impact on the structure of content, the navigation and interaction styles and multimedia features provided.
- *Bridges to web design* (see 2.5) are needed to properly guide the design decisions on the basis of the requirements.
- *Usability evaluation* (see 2.1) should be based on the definition of the goals of the site and on the goals of the users. Requirements specification should lend itself to be properly reused for the purpose of usability evaluation.

On the basis of these considerations, the next chapter will introduce and present the specific contribution of the AWARE model.

3 The AWARE Model

This chapter will firstly set the AWARE model within the development cycle of a web application. In particular, the specific contribution of AWARE within the activities characterizing the management of requirements will be highlighted (3.1 and 3.2).

A summary of the essential constructs of the model (3.3) is followed by the in-depth presentation of the conceptual tools devoted to model and analyze stakeholders' goals (users 3.4 and clients 3.5). Then, techniques to bridge the gap between requirements and web design (3.7 and 3.6) are introduced. Finally, it will be shown how AWARE enables to reuse requirements for an effective usability evaluation (3.10).

3.1 Motivation

Modern web applications are basically merging two interactive paradigms [Garzotto, 2000]. On one hand, web sites support the *transactional-style* of interaction typical of traditional information systems. Users activate complete transactions, perform operations, modify the application status, input data, receive system notifications and follow strictly predefined paths. As such, the design of this aspect of the web applications is particularly concerned with the traditional issues of transaction modelling. The user interaction is considered mainly as a sequential flow of operations and information exchanges between the user and the web server.

On the other hand, web sites support also the *hypermedia-style* of interaction derived from hypertext applications. According to this paradigm, users basically navigate in the applications selecting paths among a variety of possibilities, traverse links, locate, find, access, learn and explore content. Designers are particularly concerned with decisions about the content to be provided, the structure of the information, the navigational paths to offer and the visual aspects of the presentation.

E-commerce web sites are typical examples of this combination of interactive styles. Navigation-based user experiences such as accessing product catalogue, locating needed content, freely exploring product information, navigating to related products, changing site department are blended with operation-oriented tasks such as putting a product in the shopping bag, starting purchase process, providing authentication

information, setting payment method, setting shipping and billing address and confirming the order. It has been acknowledged that the blending of these paradigms poses new challenges for the design of the user experience [Garzotto, 2000]. Moreover, at the requirements level, stakeholders and users' goals are often conflicting (e.g. the user wants to buy a specific product, the seller wants to sell sponsors' products) and users' goals may be ill-defined (e.g. the user wants to see what the site is about).

Hypermedia-intensive web applications (i.e. those privileging the hypermedia-style rather than the transactional-style) are not systematically covered in regards to the requirement analysis concerns. Cultural-heritage web sites, educational web sites, institutional web sites, promotional and corporate web applications (and even large part of e-commerce web sites) are just few examples of domains where sites are designed first and foremost as means to communicate content and then also as a tool for accomplishing operations and transactional tasks. In such domains, stakeholders mainly need to address communication goals, i.e. they wish to use the site to get across structured messages and content to a variety of user profiles.

As discussed in Chapter 2, current requirements methods fail in providing analysts with usable and adequate conceptual tools to address hypermedia and communication requirements in web application development. Moreover, a requirement technique should be *accessible* by junior and less-experienced designers (often with no engineering background). As such, concepts and notation should be informal and as lightweight as possible. Moreover, the approach proposed must show relative advantage to project managers, requiring little training effort to be adopted and effectively integrated in the current practices.

3.2 Scope Definition

The AWARE (Analysis of Web Application REquirements) model aims at providing a support for specific activities of web requirements engineering (see Figure 4).

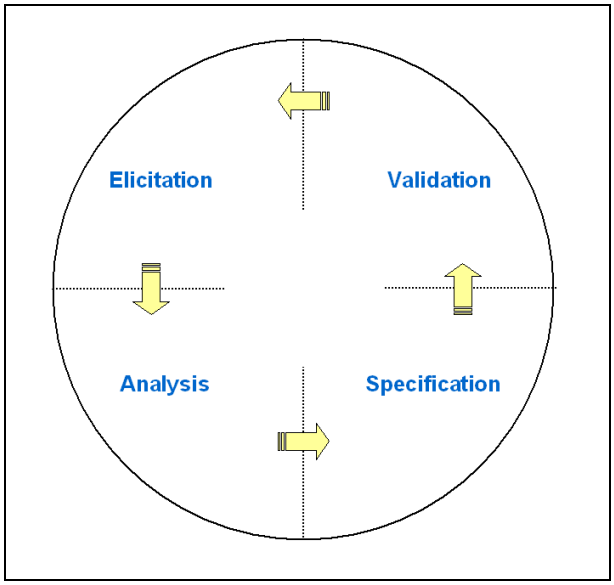


Figure 4. Requirements activities.

In general, requirements elicitation, analysis, specification and validation are tightly intertwined and iterated in the requirements process. In web development this iteration becomes faster due mainly to the limited time-to-market. Elicitation may bring to specify some requirements, to further analyse and validate them with the stakeholders. The analysis of gathered requirements needs frequent confirmation and validations from the stakeholders, which in turn may bring to negotiate or surface new requirements. These activities are thus not sequential steps, but rather iterative focuses of action.

AWARE offers specific conceptual tools for *analysis* and *specification.* However, *elicitation* and requirements *validation* can also benefit from the approach. In the context of a web project, *analysis* mainly consists in: a) pruning the expectations, goals, requirements, desires gathered during elicitation; b) prioritising the requirements; c) deciding about the application requirements according to the given constraints and the resources available. *Specification* comprises a) documenting the analysis process; b) maintaining traceability of the requirements rationale; c) defining an organized proper input for web design. As it will be showed, the specification produced are also a useful means for communication with the stakeholder during *elicitation*; besides, *validation* too can be enhanced by drawing to the traces of the analysis process.

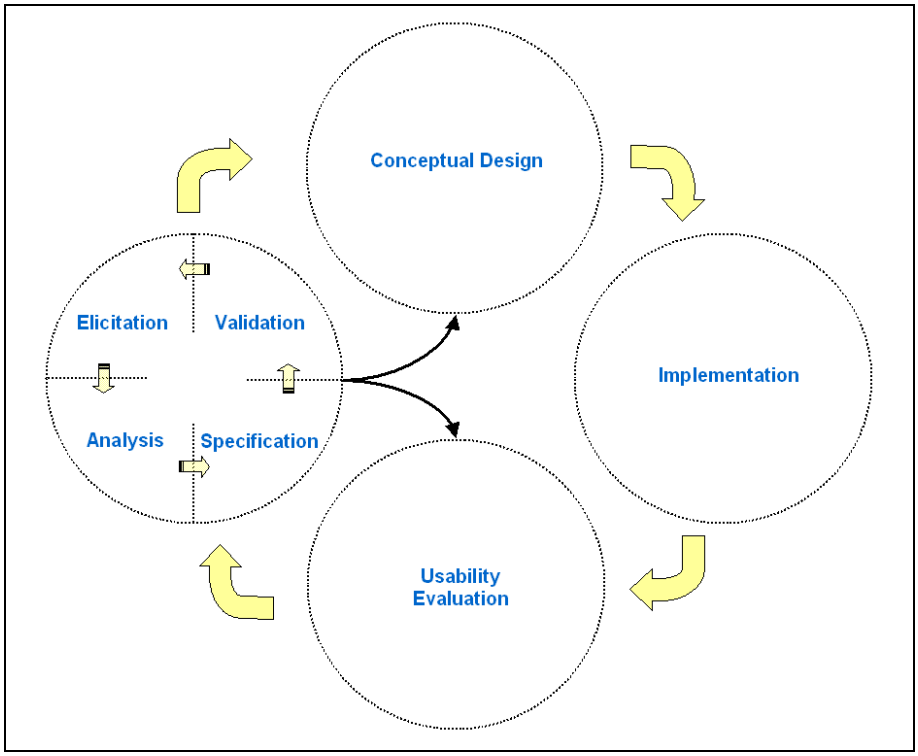


Figure 5. Requirements-driven web lifecycle.

In web projects, incremental and iterative development is the most commonly adopted practice, and it is also a research theme being explored by researchers. In fact, fast iteration between requirements, design, prototyping and evaluation is crucial. "Whereas conventional software processes tend to assume that requirements are known to the clients, and simply need to be elicited and analysed" [Lowe, 2003], in web projects clients have a poor understanding of their own needs. Therefore, design plays a major role not only in clarifying the needs of the stakeholders to the stakeholders themselves, but also in foreseeing the impact of a solution in the business and communication environment [Lowe, 2003]. As such, requirements should serve design, but design should also serve the clarification of requirements. Moreover, usability evaluation is key in validating a design solution and providing insights for uncovering requirements.

In this context, characterised by uncertainty and requirements evolution, AWARE defines strategies for the effective use of requirements in two closely related activities: *conceptual design* and *usability evaluation* (see Figure 5).

On one hand, conceptual design is (or should be) based on the requirements set. AWARE organizes requirements in such a way that designers are facilitated in planning the design tasks and in using requirements as input to existing design methodologies. On

the other hand, usability evaluation needs to reuse requirements to evaluate the application against the users' goals and the stakeholder expectations. To this end, AWARE facilitates the preparation of the tools for a requirements-based usability evaluation.

3.3 AWARE in a Nutshell

This section presents a high-level summary of the "the essentials" of the AWARE model (*Analysis of Web Application Requirements*), in order to give the reader the big picture of the contribution before getting to the details.

3.3.1 Elicitation: Discovering requirements

AWARE is not aimed at introducing novel elicitation techniques, and heavily relies on existing practices. Structured conceptual tools for surfacing and identifying goals and requirements for the application [Antón, 1997], together with general techniques such as interviews with main stakeholders, focus groups with users, brainstorming sessions and surveys may serve for the purpose of elicitation. However, along with presentation of the analysis tools, AWARE will pay – wherever necessary - some attention to distinctive aspects of elicitation for web applications. In fact, some AWARE constructs may also help analysts in eliciting requirements.

3.3.2 Analysis: Modelling and Deciding requirements

Rather than prescribing a process, AWARE provides a toolset for modelling and analysing requirements in a goal-oriented perspective. To this end, the model proposes the following basic concepts: *stakeholder, goal, refinement process, requirement, priority, requirement taxonomy, and scenario.*

Stakeholders are those who have a direct interest in the success of the web site. Stakeholders may include the users, the clients who finance the web site, and other people involved in the project (e.g. sponsor, developers, and representatives of the organization departments, etc.).

A stakeholder may own one or more **goals** with respect to the system-to-be. A goal is defined as a high-level target of achievement for a stakeholder. It may represent a wished state of affairs for the client, but also a wished experience or an expectation for a class of users.

Goals are analysed by decomposing them into subgoals, according to an *ad-hoc* **refinement process**, which consists in deciding which and how upper goals may be satisfied - according to the constraints, the obstacles met and resource available - and highlight possible alternatives. Subgoals are finally decomposed into **requirements** (both functional and non-functional) for the web site, which represent high-level descriptions of the main properties and functionality of the site. A **requirement taxonomy** classifies requirements by design dimension, which represents the hypermedia design aspect each requirement has an implication on. The design dimension is used to organize the requirements set and pave the way for a systematic design activity. The hypermedia taxonomy comprises the following eight dimensions: Content; Structure of Content; Access Paths to Content; Navigation; Presentation; User Operation; System Operation; and Interaction. The classified set of requirements represent the input for the conceptual design.

Priorities may be used to manage effectively the elements gathered during the analysis, as their size grows. A priority value may be assigned to each stakeholder, to each goal, to each relationship stakeholder-goal, and to each requirement.

Scenarios can help carry out the analysis process, by providing envisioned episodes of use of the web site, that may uncover overlooked stakeholders, surface and exemplify goals and requirements, justify the priorities assigned and lead the refinement process.

AWARE may be integrated in a lightweight and iterative development process, where stakeholders, goals and requirements are continuously defined and validated against web site designs and prototypes being made available. In fact, the refinement from goal to requirements does not represent at all a top-down process to be followed. As elements emerge from the analysis at different level of abstraction and granularity, they may be organized and rationalized according in a goal hierarchy.

3.3.3 Specification: Communicating Requirements

AWARE provides tool-independent notation primitives that may be used to help analysts perform and document the goal analysis, communicate coherently the results as they become available, and also negotiate and discuss them with the stakeholders. The basic artefact of the AWARE documentation is the *goal refinement schema*, which summarizes all the elements of the analysis.

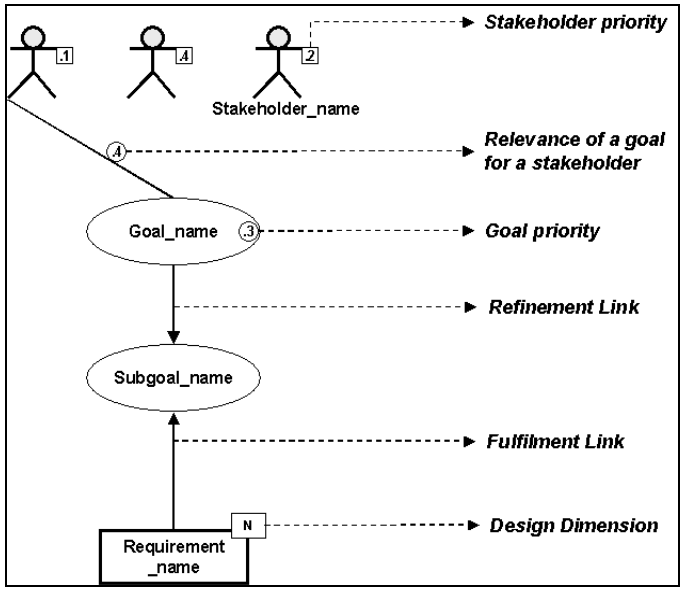


Figure 6. A basic notation for the goal refinement schema.

Icon	Design dimension
C	Content
S	Structure of content
A	Access paths
N	Navigation
P	Presentation
U	User operation
S	System operation
I	Interaction
...	. . .

Figure 7. Notation for the requirement taxonomy.

AWARE features are modular, meaning that analysts may decide which are the relevant features to include in the notation according to the audience of the documentation. Goal schemas may be read "by stakeholder", "by goal", or "by design dimension" and used for different purposes. High-level goals may be shared by stakeholders for initial validation; the set of requirements – classified according to the hypermedia taxonomy (Figure 7) – may be fed to designers. Moreover, user goals and subgoals may also help to define the tasks for the usability evaluation of the web site (prototype or final).

A basic set of notation features has been implemented in an extension of Rational Rose[5] as a result of the EU funded UWA project (Ubiquitous Web Application, IST-2000-25131).

[5] The prototype of the tool editor is freely available for evaluation at ftp.robotiker.es/ incoming/uwa. User name: *uwa*; password: *uwaftp14*. The tool is an add-in of Rational Rose; therefore it works on a previously installed version of Rationale Rose.

3.3.4 Novelty introduced by AWARE

Table 2 shows the aspects that distinguish AWARE from existing goal-oriented requirements engineering frameworks.

Aspects of Goal-Oriented Requirements Engineering	**Novelty introduced by AWARE**
Stakeholder	User persons User roles Various categories of main stakeholders
Goal	Communication goals Ill-defined user goals
Requirement	Hypermedia web requirements taxonomy
Refinement process	Relative to the needs and constraints of the project
Scenario	Distinction between client scenario and user scenarios
Priority	Stakeholder, stake, and goal priority Priority propagation from goals to requirements.
Transition to design	Facilitate transition from requirements to web conceptual design
Requirements reuse	Reusing requirements for systematic usability evaluation

Table 2. Novelty introduced by AWARE.

By starting from key achievements of traditional goal-oriented requirements engineering techniques, AWARE introduces novel concepts to support the work of web analysts dealing specifically with web applications.

The next chapters will be devoted to explain in depth the AWARE constructs.

3.4 Modelling User Goals, Persons and Roles

Modern web sites are designed to fulfil two sets of objectives: the communication purposes of the stakeholders who conceived the web site, and the support of the tasks 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 advantages and the successes 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, and so on.

As web sites are used by corporations and institutions more and more as structured means of communication, main stakeholders and designers should presuppose an intended target audience [vanDerGeest, 2001]. In fact, the more the characteristics and the expectations of the addressees are known, the more the communication act has chance to succeed. The problem is that potential web site users have different profiles and have a variety of (quickly changing) needs, which are difficult to identify for effective accommodation in the design. Moreover, clients and main stakeholders often are not aware of the target audience of their web sites and expect from analysts and designers effective techniques to gather and define user requirements.

Analysts should explore the salient scenarios in which users will approach the web site and define strategies to meet their expectations and goals. On the basis of a proper understanding of user requirements, guidance should be provided to the design activity. Informal methods for communicating user requirements and envisioning alternative design solutions should be easily understandable not only by analysts, but also by less-experienced web designers (often with little technical background) and customers.

Current practices in web site development acknowledge the importance of defining user requirements. Practical tips include advice on how to conduct research about user characteristics, condense the results in user profiles and define the relative set of tasks to be supported [Garrett, 2002][Cato, 2001]. Application requirements and design prototypes are then shaped on the basis of this information.

These approaches consider users only in regards to their functional requirements (achievement of operative and precisely defined tasks). Ill-defined and qualitative

aspects of the user experience (such as expectations, intentions and preferences) are not usually integrated in the analysis. Finally, current practices rely almost entirely either on the skill of the analysts (hardly reusable by less-experienced analysts) or on extensive ad-hoc user research (hardly reusable across very different projects).

As such, AWARE introduces a conceptual modelling framework for user requirements to support complex web site design. It employs the concepts of user *persons* and *roles* in order to separate as clearly as possible the dimensions composing user requirements. 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.

Separation of concerns between the various conceptual dimensions of the user experience enable analysts to build a systematic and reusable toolset for combining user persons and roles, prioritizing user requirements and communicating them to the stakeholders.

3.4.1 User Profiles

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].

A user profile usually describes stable archetypal qualities of a relevant target segment [Carroll, 2000] 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, first time user, experienced user, hardware and software constraints, favourite sites, etc.) [Garrett, 2002]. For example, Figure 8 shows the user profiles identified for a museum web site[6].

[6] The example treated in this chapter has been defined as a didactic example, but it is based on the early phase of the requirements analysis carried out for the website of the Munch's prints collection of the Berliner Gemaldegalerie of modern art (www.munchundberlin.org). Requirements and design are coordinated by the Technology Enhanced Communication Laboratory (TEC lab) of the University of Lugano (www.tec-lab.ch).

Profile_1	
Occupation	Teacher
Age	25-50
Net usage	0.5 hour per day
Access speed	Ethernet
Languages	German, English

Profile_2	
Occupation	Student
Age	15-25
Net usage	2 hours per day
Access speed	56 KB/sec
Languages	German, English

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

Profile_4	
Occupation	Tourist
Age	25-50
Net usage	1-2 hours per day
Access speed	56 KB/sec
Languages	English

Profile_5	
Occupation	Journalist
Age	25-50
Net usage	4-8 hours per day
Access speed	Ethernet, 56 KB/sec
Languages	German, English, French

Figure 8. 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.

However, at a closer look, a profile 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 (128Kbs-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 (e.g. indexes and search mechanisms) differ for the ones needed by first time users (introductions, guides through the topics) [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 8 (e.g. an art expert can be a teacher or a journalist), and yet needs to be taken into account separately from the others.

The premise of the AWARE approach to user requirements is that many of these dimensions concerning user characteristics are *orthogonal* and may be treated *separately*, based on the principle of separation of concerns[7]. 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.

3.4.2 Making Use of User Scenarios

Following the guidance of the current practice in web development, once user profiles are identified, goals and tasks are usually associated to each profile. In fact, a user may access a web site for a variety of purposes: finding specific information, gathering elements to take decisions, getting an idea of the content offered, etc.

In HCI, task-based techniques for interface design acknowledge that one or more tasks may be associated to a user profile [Marchionini, 1995]. However, whereas tasks are used to describe precisely-defined and focused aims of the user interaction, and the actions needed to accomplish them, the more general notion of *goal* is advocated in RE to define wished states of affairs for the users that do not commit on premature design solutions and do not depend on a given style of interaction [Garrett, 2002] [Yu, 1997] [Antón, 1997].

A *user goal* is thus defined as a high-level target of achievement for a user profile. In the museum example, the user profile `Teacher` may own goals such as `Organize an educational visit`, `Prepare introductory lesson before the visit`, and `Get useful catalogues for teaching`. On the other

[7] Considered a fundamental principle in software engineering, “separation of concerns” [Ghezzi, 2002] may be used in this context to discover requirements for each orthogonal aspect of the user that we want to consider.

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 obtained by encouraging stakeholders, user representatives, analysts and designers to elaborate user scenarios through interviews and focus groups. Scenarios are known and widely used both in HCI and RE as informal descriptions of episodes of use of the application that stimulate designers to reflect upon concrete circumstances of interaction [Carroll, 2000]. In web site development, scenarios are used in requirements [Broadbent, 2000], design [Garrett, 2002][Cato, 2001] and evaluation [Brinck, 2002]. For the analysis of user requirements, scenarios can stimulate the identification of user goals because they consider a specific user in her everyday context, detailing the circumstances from which goals may arise. An example of a scenario defined for the profile `Teacher` 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 lunchtime, 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. Then, she searches for an explanation of four famous works, background information and references and she bookmarks the pages containing the needed material.

As such, scenarios may be useful to exemplify profiles and 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 at least for two reasons.

a) They may introduce detailed design features (needed to envision the user interaction) that are premature to commit on; assumptions on content available, navigation and structural features should be questioned during requirements analysis and not taken for granted.

b) They are incomplete and partial descriptions. Scenarios 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.

Note that user goals and user scenarios should not arbitrarily describe whatever the user would like to do (based only on the intuition of the analysts), but rather the reasonable conclusions - about what the user might want to accomplish with the site – drawn either from the results of user research (brainstorming, interviews and focus group with users), from past project experiences, or from the insights gathered from clients and main stakeholders.

3.4.3 User Goals and Softgoals

In principle, goals are high-level user objectives and should therefore precede the definition of tasks. However, in practice, the level of granularity of goals gathered during requirements elicitation may vary considerably. It covers a continuum from operative tasks (describing a user action such as: `Find work of art X`) to ill-defined and wide open goals (describing a wished state of affairs such as: `See if the museum is worth visiting`). In fact, user needs are not necessarily pre-formed in a clear-cut fashion when visiting the web site. Oftentimes, web users have unfocussed goals and unconsciously assign to the site the responsibility of going beyond expectations and prompting goals in the user's mind.

To give reason of the complexity of the web user experience, user requirements should not only capture functional objectives of the user, but also attitudes and expectations towards the site. To this end, goal-oriented RE employs the notion of *softgoal* to identify qualitative expectations as opposed to functional achievements [Chung, 2000]. Softgoals help to uncover non-functional requirements relevant for the user experience (such as accessibility, accuracy, usability, security, trust, etc.) [Yu, 2001]. For example, the profile `Teacher` may have the general expectation of finding *accurate* descriptions of the work of art on the museum. 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. It may be argued that content should always be accurate, current and attractive. 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.

Softgoals need to be treated differently from functional goals because they have no clear-cut criterion for satisfaction. As such, they are elaborated and interpreted by selecting increasingly specific methods for addressing them during requirements elaboration and design process. They express web site properties that may leverage the quality of the design and, consequently, the fulfilment of user expectations[8].

3.4.4 Ill-defined User Goals

Softgoals capture also the situations in which web site users have a poor understanding of the goal of their interaction, just because they do not have a precise objective. In fact, anecdotic evidence shows that an important target of web users "surfs" a site just to be attracted by something interesting.

This lack of specificity about the user goals has been called an "anomalous state of knowledge (ASK)" [Belkin, 1982]. However, this strongly "negative" definition (anomalous) suggests that the users should have – under normal circumstances – a clear and distinct knowledge about the tasks he might want to complete on the site. That is due to the fact that in the design of systems purely supporting information retrieval, user tasks are supposed to be clearly defined most of the times; vague goals represent a problematic situation to cope, and, if possible, to reduce to more manageable user tasks. In the web domain, it seems more adequate to consider these high-level goals a "normal" scenario in which users approach web sites.

In the example of the museum, the user might want to be supported in "`Deciding if the museum is really worth visiting`". Let us think to the web site of an online newspaper: site users might have well-defined tasks such as `Find a specific article`, `Downloading a picture or printing the editorial`. However, a typical attitude of the user approaching such a site would be curiosity, expectation of a novelty, or just superficial interest in "`what happened today`".

Similarly, a tourist web site for a large city should be addressed to first time visitors who "`Expect to be guided in the choice`" of selecting what is

[8] A comprehensive classification of non-functional requirements for interaction design can be found in [Chung, 2000].

really worth visiting in their period of staying. In this case, users goals are vague, hard to formalize in tasks, and yet their fulfilment is crucial to the user experience.

Also in the case of an educational web site, users' goals may be not precisely defined: for example, first time users need to be `introduced to the course topics`, `have an idea of the material available`, `understand the coherence of the educational path proposed`, and `organize the personal learning activity`. Precise tasks are instead typical of frequent users who may, for example, use the material for revision: `finding a specific passage in a lecture`, `locate bibliographical information`, `retrieve an example and selecting an exercise`.

Users needs to be addressed are not necessarily pre-formed in a clear-cut fashion in user's mind. In these interaction contexts, users unconsciously and implicitly delegate to the site the responsibility of fulfilling, and even going beyond expectations by prompting new goals in the user's mind.

These goals can be characterized in at least three respects:

1. From the user perspective they are *unfocused* and *open* because they do not state clearly a specific target of achievement for the user experience. In other word, they do not make necessarily converge the scope of the interaction to retrieving a piece of information, but they leave open the user expectations.

2. From the designer perspective, they are *ill-defined*, because they are not readily reducible to well-defined tasks to be readily mapped onto interface features.

3. From client and main stakeholders perspective (i.e. from the point of view of the people who conceive the web site) these goals are *malleable* because they may potentially change and evolve along the session due to their open nature, making room for the site communication strategy to provoke a true "habit change" in the user experience. As defined by Pierce [Pierce, 1907], a habit change - purpose of authentic communication – is a modification of the user attitude in a way that allows him/her to better understand the reality.

As such, ill-defined goals are structurally different from the traditional concept of *task*, so as it is employed in HCI and IR [Bolchini, 2003]. Whereas a task is satisfied by a sequence of functionalities activated by the user on the interface, softgoals (including ill-defined goals) need a specific design elaboration: they are open-ended user needs that

may be *somehow* supported by an accurate combination of content, navigational possibilities and functionality. In fact, the satisfaction of softgoals is nor complete or optimal but rather "good-enough" [Mylopoulos, 1999].

In other words, whereas for a well-defined task such as `Find the price of product X` it is possible to determine a clear-cut criterion for its satisfaction, for an ill-define goal such as `Being guided in understanding the new product features` it is only possible to reason and provide arguments about the effectiveness of a design solution.

3.4.5 Modelling Scope and Granularity of User Goals

Having considered also ill-defined goals in our analysis, it is clear that user goals may span along a wide range of granularity, from very specific to broad and open-ended. At a closer look, the level of abstraction of a user goal is determined by the combination of two factors: *user scope* and *application scope*.

The *user scope* represents the degree of transparency and precision by which the goal circumscribes the user experience. Along the user scope dimension, goals vary from generic and open-ended interests, to cognitive, learning, emotional goals (where the satisfaction criterion is very subjective), and to informative, operational, transactional tasks (e.g. find, buy, check).

The *application scope* is the degree of granularity by which the user goal involves a part of the application domain. Along this dimension, user goals vary from generic themes of interest, topics, and content categories to specific pieces of content and information slots.

The complexity of user goal modelling is partly due to the fact a goal may be positioned in a *continuum* on user scope and application scope. Figure 9 summarizes the dimensions characterising the granularity of a user goal, identifying the kind of user interaction along each dimension.

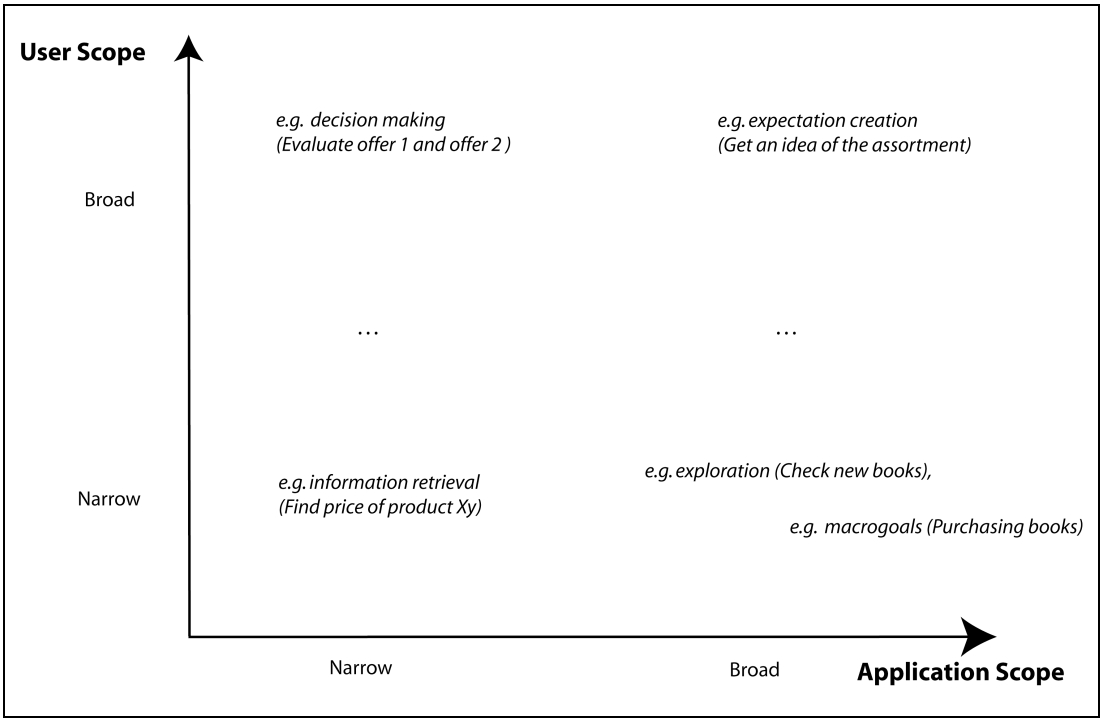


Figure 9. Dimensions of user goal granularity.

It would be unrealistic to draw a fixed and universal taxonomy of user goals, since their variability along the two dimensions covers a non-discrete spectrum and it would be strongly influenced by the domain. However, as example, it is useful to associate possible styles of interaction along each of the two granularity dimensions.

Whereas traditional task-based techniques tend to deal with goals that are narrow both along the application and user scope, the resulting analysis focuses on interactions that are mainly suitable for accomplishing information retrieval tasks. Basically, the issues guiding the analysis of user goals within this area of concern can be summarized in the question: *What is the user looking for?* Examples of these goals are traditional "search-oriented task" such as `Locate product Xy` or `Find the price of product Xy`, `Find the latest book of author X.` Moreover, in this area also operational and low-level transactional tasks fall: "`insert personal data`", "`put an item in the shopping cart`", "`remove an item from the shopping cart`", or "`send current page to a friend`". Going towards fine-grained tasks on both dimensions, we encounter tasks even more limited in scope, such the user actions on the interface addressed by the GOMS models [John, 1996].

The more we move along the user scope dimension, yet keeping narrow the application scope, the more we broaden the spectrum of user experiences considered. In

fact, at this level we can deal with more complex goals, such the ones concerning decision-making or planning. According to these goals, the user employs specific information to accomplish higher-level tasks. For example, a goal of a teacher visiting the web site of a local museum may be to `Find a suitable educational path about a specific topic.` Or, a more practical goal would be `To see how to reach the museum with his/her class,` or `Understand how much material is offered about a specific artist.` A question addressed by these goals might be: *What the user might want to do with the information?*

Shifting on a much broader application and user scope, we consider goals that express high-level and unfocused user experiences without assuming a specific target of content or service. Here the ill-defined goals fall, and the style of interaction to be supported concerns the creation of expectations in the user, and more sophisticated experiences (e.g. launch of innovative services, cooperative environments, etc.). The question to be considered is: *What the user would like to be engaged in?* Note that these concerns may be insightful for traditional services also, such as e-commerce services or edutainment applications, where user goals have to be somehow created and prompted. For example, in an e-commerce web application, a typical user goals (especially for first time users) is `To get a idea of the variety of the products offered, Understand what the site is about,` and `See whether the site has something interesting to offer.`

Finally, keeping broad the application scope and narrowing the user scope, we come to consider more general goals (or macro-goals) of the users. In the case of an e-commerce web site, it is the case of goals such as `Purchasing Books`, `Finding the news, Check today's offer,` etc.. In a university web site, examples of this kind of user goals are: `Find information about the faculty staff, Enroll to the university, Learn about programs and courses`. These macro-goals express general situations of usage of the applications, and may be exploited to define low level user goals.

Note that there is not strict borderline between the interaction styles and between the classes of user goals. The distinction between *narrow* and *broad* on each dimension is not absolute and definitive. Each project team, during goal elicitation, revision, and analysis, will converge to its own borderline, defined according to the project needs and constraints, and the granularity of goals most convenient for that project. The examples provided here are aimed to support project team in this assessment, serving more as guide and suggestion rather than a prescriptive taxonomy. Analysts should achieve an agreement about the point of discrimination between the areas identified in the chart. In

this way, it would be possible to explore separately each style of interaction and make goals surface.

Analysts and designers of a complex web site aimed at offering a variety of services to a variety of users, may find useful to explore in-depth the entire spectrum of goals. The pay-off would be to be able to uncover a larger set of user needs that will not emerge at a more superficial analysis, and to pave the way for offering a richer and more satisfactory user experience.

3.4.6 Going Beyond User Profiling: Separating Concerns

A goal is usually associated to one or more profiles. However, since a profile is already an aggregate of various qualitative and functional dimensions, we claim that decomposing further a user profile in separated concerns may help to gather a more accurate set of requirements.

Consider a profile 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. 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 will have their own goals and expectations with respect to the web site-to-be.

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*.

3.4.7 User Persons

A *person* is a modelling abstraction used to identify a “personal” characteristic of the user. Personal characteristics may be chosen along any dimension that analysts consider relevant for the design.

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, first-time visitor tourists, etc.

Persons may be defined along any of the orthogonal dimensions (e.g. site knowledge, familiar relationship, level of disability, age, domain expertise, occupation, etc.)

containing user characteristics. Dimensions coexist in the analysis and may be all considered for the design.

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 just one relevant dimension of a profile (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.

In the case of web sites with a rich communication potential and service diversification, neglecting the person definition may bring analysts to commit on poor or unreasonable user requirements.

Poor user requirements occur when, for example, the needs of a relevant user segment are not accommodated. For example, tourist information is missing on a museum web site designed to attract new visitors to the museum. Unreasonable user requirements occur when a set of services is designed, but it is not clear the relevant persons that might be interested in those services. For example, the detailed map of the museum is published on the web site but the designers have no idea as to whom it may be really useful.

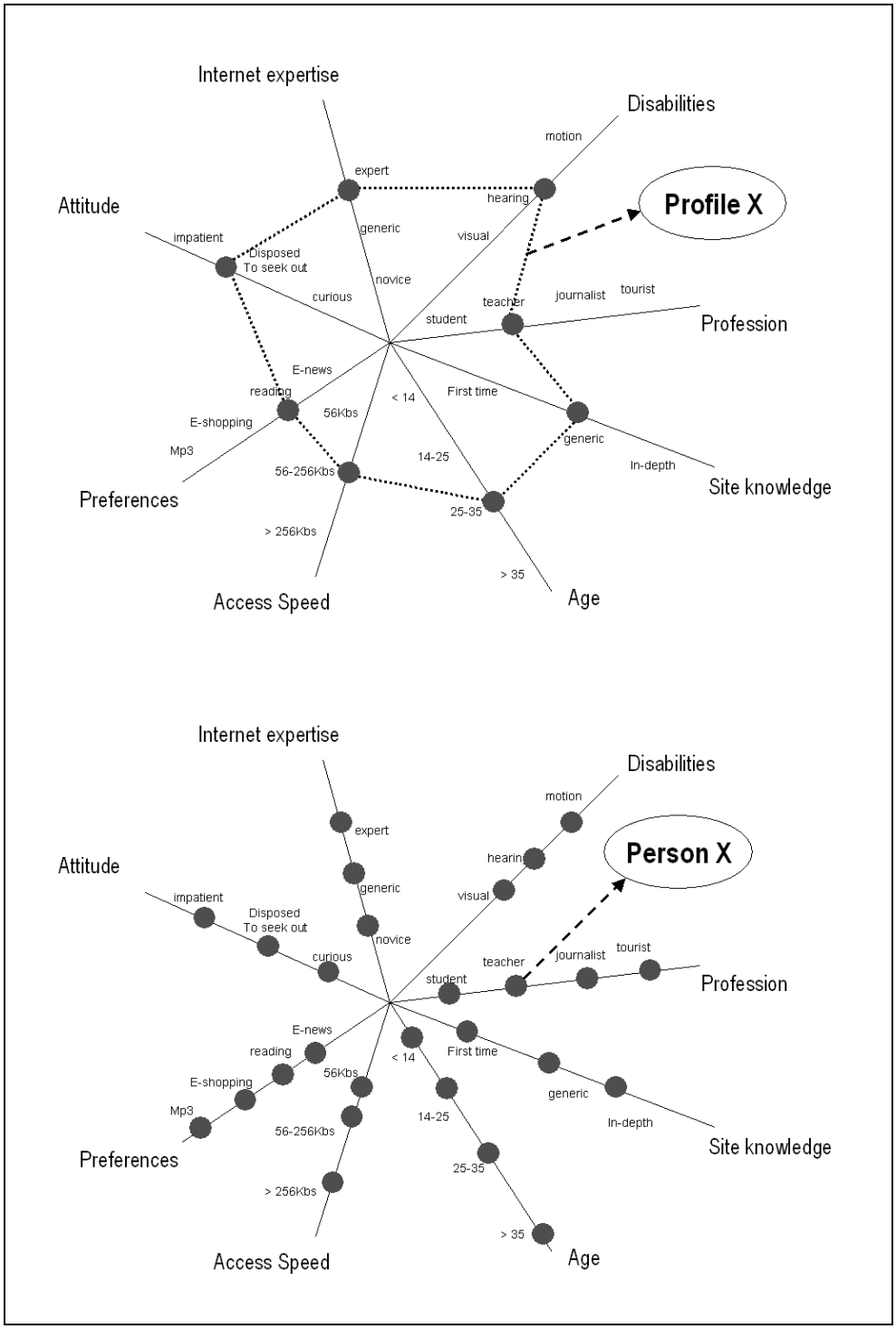


Figure 10. From user profiles to user persons.

As such, during requirements analysis, the set of relevant persons has to be kept as wide as possible and always revisable. Analysts should not prematurely remove any target user emerged during elicitation; reducing the spectrum of persons too early in the process may jeopardize the effectiveness of the site's communication strategy and the quality of the user experience.

3.4.7.1 Eliciting Persons

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.

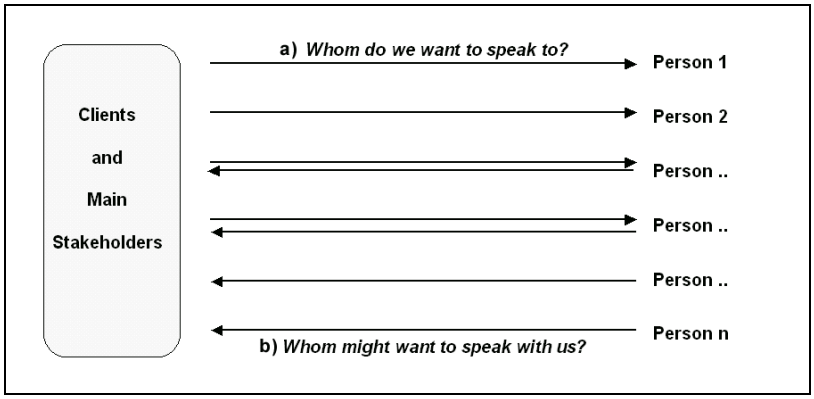


Figure 11. Discovering *persons* from the clients and user perspective.

Figure 11 shows that exploring *persons* from the clients and main stakeholder point of view (a), and from the user point of view (b), analysts are enabled to enrich the requirements picture, by considering a broader potential target audience.

As shown in Figure 11, it may happen that a *person* is relevant from both viewpoints: both because the stakeholders want to address it, and because – at the same time – this *person* may own have tasks and goals to accomplish on the application. This is the case when the arrow becomes two-way.

3.4.7.2 Person Goals

During the requirements analysis for the museum web site, we defined persons according to the *occupation* and *mind-set* dimensions. `Student`, `Art Critic`, `Teacher`, `Tourist` and `Journalist` are then intersected with mind-sets such as `easy guidance preferred`, `disposed to explore`, `easy irritable`, `impatient`, and `disposed to seek out`.

User goals, softgoals, mind-set and priorities may be defined for each user person (see *Person Goals* in Figure 12). 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 would person X might want visit the site for? What are her expectations? How will she approach the site?*"

Priority	Person	Goals	Softgoals	Mind-set
0.2	**Teacher**	• 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**	• 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**	• 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**	• Organize a leisure visit • See if the museum is worth visiting • Get an idea of the collection • Check for works of famous auhtors • Check parking possibilites	Attractive	Easily irritable
0.2	**Journalist**	• Contact museum PR • See if the museum is going to organize "news" events • Check institutional info	Accuracy Conciseness	Impatient

Figure 12. Person Goals.

3.4.8 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 task-related characteristics. In fact, *persons* are not directly related to the intentions towards the application; a *role* instead models a behavioural 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.

3.4.8.1 Discovering Roles

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 project team 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 behaviours may help abstract the design experience 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.

Suggested 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.

3.4.8.2 Role Goals

Reflection about user roles may generate a separate set of user goals and softgoals, with associated role priorities (see *Role Goals* in Figure 13).

Priority	Role	Goals	Softgoals
0.2	**Casual**	• Be attracted by something interesting • Get an idea of the collection	Attractiveness
0.15	**Picture Eager**	• Download pictures • Tell a friend	Copyright free, High-quality pictures
0.3	**Visit Planner**	• 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**	• Collect works information, artistic movements and author bios • Look for works details • Compare works	Accuracy, Richness
0.2	**Events Checker**	• Look for interesting current exhibitions • Browse archive of past events • Check for planned events	Accuracy, Conciseness

Figure 13. 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 favoured 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 user in this attitude? How will she approach the site?"*

3.4.9 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.

Ideally, it would be recommendable to have a scalable technique for addressing a large numbers of persons, roles and goals. However, scalability may be partially addressed by introducing priorities. 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] [Fraser, 2003].

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. As shown in Figure 12 and Figure 13, 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 motivation for using the site (e.g. `Fact finding` or `Visit planning`).

For the use of priorities in later stage of the requirements analysis, we refer to Chapter 3.7.

3.4.10 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 some target audience (e.g. students) is extremely relevant for the site. However, when asked, it is difficult for them to imagine possible 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 (usual museum visitors) 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. Not that, at this stage, goals may describe both high-level objectives and fine-grained tasks as well.

3.4.11 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*).

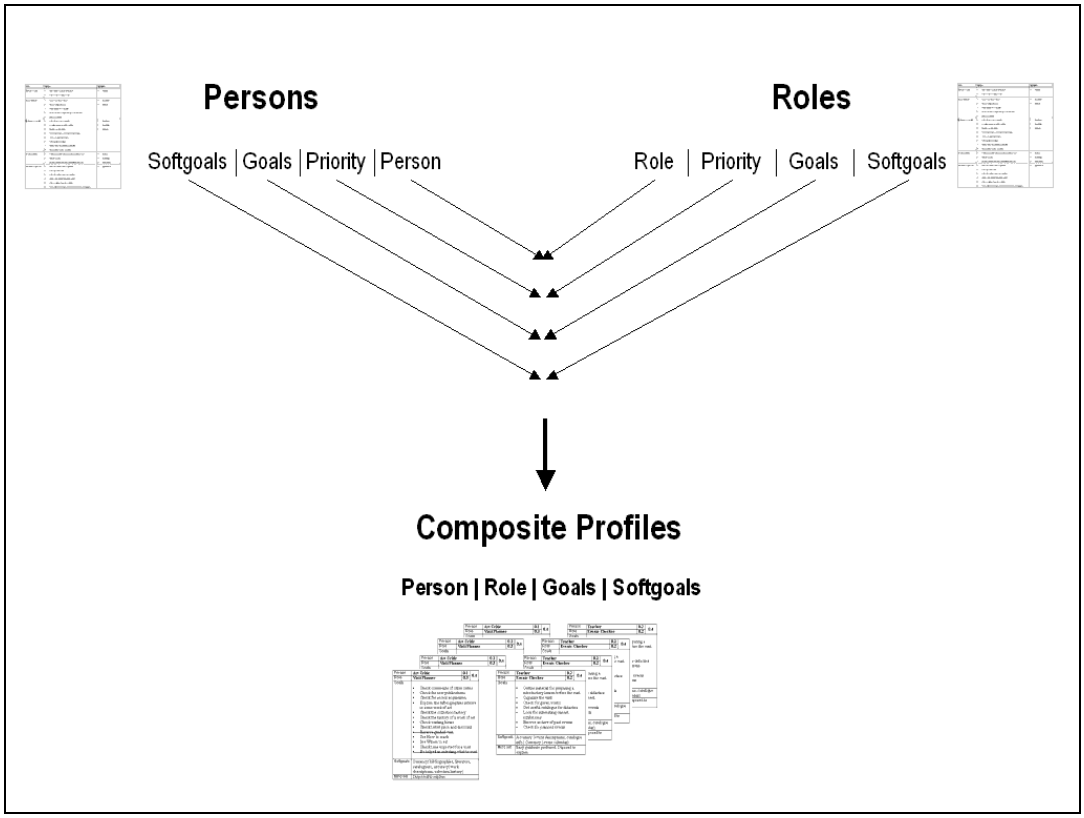
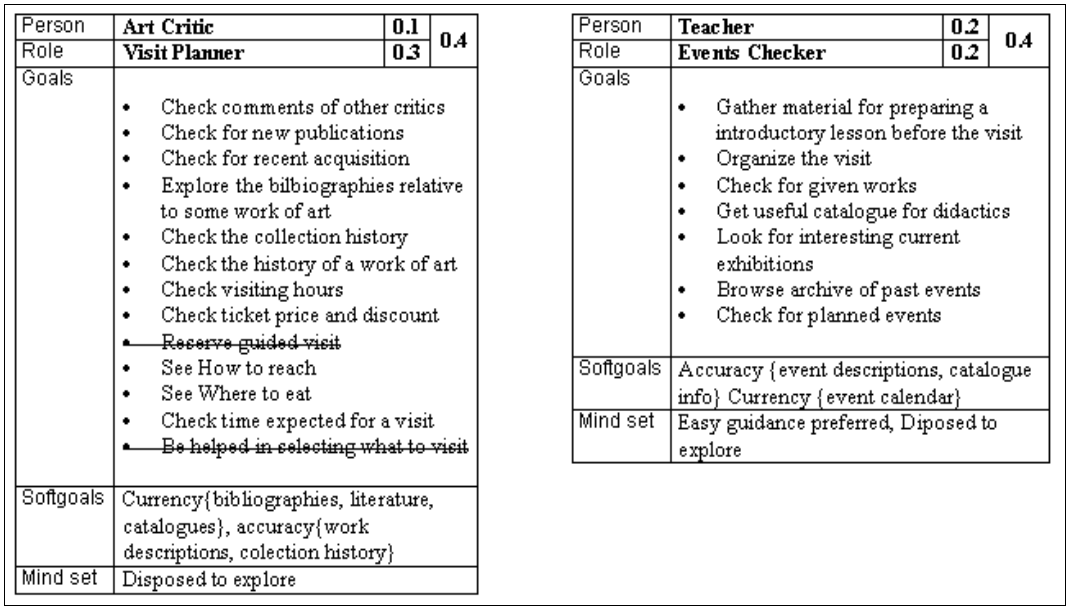


Figure 14. Creating composite user profiles from persons and roles.

A *User Composite Profile* (see Figure 10) 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. by average, addition, or multiplication, etc.).



Person	**Art Critic**	**0.1**	**0.4**
Role	**Visit Planner**	**0.3**	
Goals	• Check comments of other critics • Check for new publications • Check for recent acquisition • Explore the bilbiographies 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, colection history}		
Mind set	Disposed to explore		

Person	**Teacher**	**0.2**	**0.4**
Role	**Events Checker**	**0.2**	
Goals	• 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, Diposed to explore		

Figure 15. Examples of two user composite profiles for the museum web site.

Information collected in each user composite profile may be redundant or inconsistent. Therefore, goals, softgoals and mind-sets may be rethought, 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, as outcome of a focus group, 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) turned out to be not relevant for an art expert, and are 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 description*s are accurate and the *calendar of events* is up-to-date.

Ideally, combining five user persons with five user roles, twenty-five user composite profiles may be defined. However, 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 and softgoals 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 clients and main stakeholders.

3.4.12 Meeting Changing User Needs

Within the same session, the user may shift from one goal to another, spanning all along the degrees of granularity identified. In fact, after having completed a task, or in the middle of the execution of a task, the user may want to accomplish other tasks and goals. Moreover, especially in case of ill-defined goals, user needs and expectations may be affected by the content communicated along the session, and thus bringing the user to conceive new goals and tasks.

Users do not only have changing goals, but the same user can span different *persons.* In fact, the same user may be modelled as a first time user as s/he access the web site for the first time. Obviously, after several visits, this user has to be considered as a frequent user, and, ideally, s/he would find a design corresponding to his/her new requirements and goals.

Requirements analysis should be aware of the fact that user persons, roles and goals may evolve. Consequently, analysts should try to accommodate these changing as much as possible and as more effective as possible, according to the constraints (technological, temporal and financial) of the project at issue.

A possible approach to meet the changing needs of specific users is explored by the adaptive hypermedia community [Wu, 2001]. An adaptive hypermedia is a hypermedia application that acknowledges the user and, according to a predefined user model, adapt content, services, navigation capabilities and presentation features to the his/her specific needs. Adaptive hypermedia applications assume that it is possible to explicitly model the requirements of a specific individual user from the outset, so that the system may, at runtime, be tailored to meet these requirements. This is an interesting research stream that, however, starts from the assumption that there is *something* that is the object of the adaptation. Adaptive technology, by definition, focuses on the techniques to tailor an *existing* design to the needs of the users. Where does this basic design come from? How has it been shaped?

Requirements analysis should foreseen as much as possible the whole spectrum of user needs up-front and shape one initial design that may accommodate them.

For example, significant changes to the content and to the information architecture need to be treated at *design time* (and not at run-time), since they entail re-investigating the requirements and the project constraints.

Adaptive technologies may be suitable for activating detailed design changes – on an existing architecture - triggered at run time by user-based rules that have to be stable and explicitly identified during the requirements analysis.

Therefore, an iterative development process that addresses changing user requirements at design-time (a) may be seen as complementary with a adaptive rule-based approach that tailor the application at run-time (b). This thesis focuses on providing analysts with conceptual tools of kind a), assuming that tools of kind b) might be used on the basis of that.

3.5 Modelling Clients and Main Stakeholders Goals

It is often claimed that the development of websites should be user-centered. A common understanding of this expression is that designers should design primarily to serve the goals of the user. Although partially true, this perspective does not capture the whole complexity of modern web application development, mainly for two reasons.

Firstly, as illustrated in Chapter 3.4, oftentimes designers do not have to cope just with one user, but with a wide variety of possible users to address. Decisions and compromise to serve effectively the goals of all these various users is not a trivial task.

Secondly, as it will be discussed in this chapter, users are not the only design target of the website: clients and different stakeholders have their own objectives, interests, and expectations towards the website and its users. As such, it would be more correct to say that designers have to design *with the user in mind* in a *stakeholder-centered* perspective.

The notion of *stakeholder* is a general concept widely employed in requirements engineering as well as in other disciplines, such as corporate communication, strategic management, marketing and media design.

In RE, as defined in [Potts, 1994], a stakeholder is anyone who can share information about the system-to-be, its constraints, or the problem domain – including end users, customer representatives, and developers. As such, stakeholders are identified by their interests in the success of the system and by the reasons they may somehow benefit from it.

The communication paradigm established by a web application is not always just one-to-many (an organisation communicating to a variety of users). Web applications may be designed to meet requirements, goals, and expectations coming from different sources of interests, namely different stakeholder and different partners, and addressed to a variety of end-users. As such, the paradigm to be better considered should be *many-to-many*. Requirements analysis should support the proper management of requirements coming from the needs of all the relevant main stakeholders, and from the user needs.

In this chapter, we will consider different categories of stakeholders, who may have in turn a variety of business and communication goals, interests, decision powers, and expectations with respect to the web site-to-be.

3.5.1 Categories and Roles of Stakeholders

The types of stakeholders vary considerably from project to project, depending on the organisations and partners involved, the size of the project and the perceived impact of the application on the environment. For small web projects, the interface between the world of the stakeholders and the web developers team may be represented by just one person, who is the client herself, or is delegated by the client to represent their interests and vision. For larger web projects, the people to involve may be numerous and coming from different organisations, businesses areas and departments.

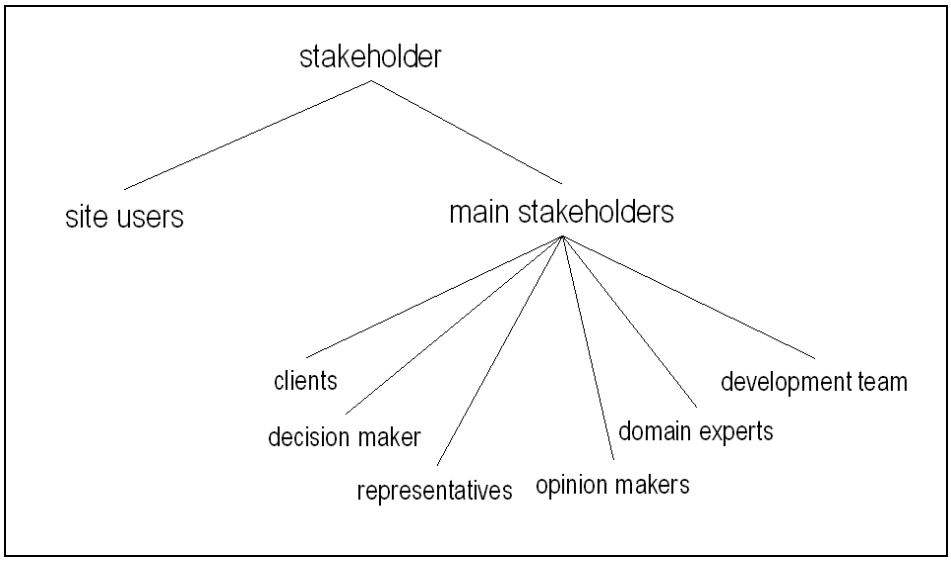


Figure 16. A taxonomy for the stakeholders.

The various kinds of stakeholders may be summarized in general categories (see Figure 16), as it will be explained in the next paragraphs.

3.5.1.1 Clients

Clients - the customers for whom the designers do the job - are those who need the web site, and fund the construction and the deployment of the system. Clients are the primary communication partners of the project team (represented by analysts or designers). In fact, analysts should keep in contact on a regular basis with the client all along the lifecycle, from requirements to web site deployment. In regards to requirements management, clients and analysts should negotiate requirements, validate them, and, eventually, agree.

3.5.1.2 Decision Makers

There are clients who have the actual decision and contractual power on the project. They decide to sign the contract, to stop the project, to restart it. In short, they have the "final word" on the web site. The may or may not coincide with the people that meet and work together with the web design team to share information, goals and providing feedback about the site being developed. In fact, often decision makers (due to their busy schedule, or because devoted to more managerial tasks) delegate to other people – usually within the same organization – the task of communicating and working frequently with the analysts and designers, and giving short-term feedback to the team about the project.

3.5.1.3 Representatives

Representatives of institutions, companies or departments may be involved directly or indirectly in the strategic decisions about the purposes and the success criteria of the application. It may happen that the decision power about the site-to-be is spread out all along an organisation or an institution. The representatives of the different departments of an organization, or a public institution have different viewpoints [Leite, 1996], interests, and degrees of decision power about a specific portion of the project at stake. For example, each representative claims the site has to address a specific target audience – the one interesting their specific business – with specific purposes. On this basis, they expect the site would deliver the set of services corresponding to those goals.

Ideally, analysts should be able to manage this complexity, reconcile viewpoints and deriving a consistent set of requirements satisfying everybody's needs and goals.

3.5.1.4 Opinion Makers

Opinion makers are those who may influence the decisions of the decision makers or other representatives. For example, in a large organization, some subordinates, who are not supposed to represent any interest from the organizational point of view, may be key to contact in order to understand better or to influence the point of view of other stakeholders that s/he knows better or with whom s/he spends most time together at work.

3.5.1.5 Domain Experts

Domain experts are those who represent an important source of knowledge and expertise about the specific topics, contents and services the web site is supposed to offer. Communication strategies are significantly affected by the specific content at issue; therefore, domain experts can be crucial to shape the communication effectiveness of the content, to understand the levels of details by which the content has to be conveyed, and the users to whom this content is addressed. Being the content still the most important asset of a content-intensive web application, domain experts are important partners in the requirements analysis and in the design because they may be those who will actually provide the contents to the project team.

3.5.1.6 Development teams

The set of stakeholders may be enlarged to include also the *analysts*, the *designers*, the whole *development team*, and the people responsible for the *deployment*, *management*, and *evaluation* of the website.

These stakeholders may dictate goals and requirements for the website. Their interests and expectations come from the perspective of the people who contribute to "build" the web application, aiming at delivering and managing a quality product within convenient contractual, financial and technological constraints. Wherever needed, requirements analysts should document these goals, and properly inserting them in the requirements analysis picture.

The described categories indicate aspects that may overlap on one stakeholder. In fact, each category points out a predominant role a stakeholder can play. However, in a project, the same stakeholder can play different roles at the same time.

Clients may be either decision makers or representatives. In turn, decision makers may also be client representatives. Domain experts may be clients, but also independent actors. Opinion makers may be representatives, domain experts, or external figures.

Let us consider an example of diversification of stakeholders in a real project. During the development of the web site of a research institute[9], the project team had to negotiate

[9] The project – carried out within the Webatelier (www.webatelier) of the University of Lugano – was realized in winter 1999 by the author of this thesis together with other two students: one from the Faculty of Communication Sciences, and the other from the SUPSI graphic school of Lugano.

the requirements with a chief researcher of the institute, who was both the *main decision maker* and a *representative* of a research department. On one hand, the stakeholder was very concerned about the success and the quality of the overall project; on the other hand, he had a strong interest in the part of the site describing his/her own research group.

Another chief researcher accompanied the first stakeholder in all the meetings held with the project team. This person was a representative of another department but had no decision power on the project. However, this researcher has a strong influence (opinion maker) on the decisions that the decision maker might have taken.

This classification of stakeholders may make the analysts aware of the different roles played by the stakeholders and of the importance of looking for relevant persons to consult and to meet other. Since each type of stakeholder may make a contribution to the effectiveness of the web site from a particular viewpoint, analysts may want to consider this complex picture to obtain a more accurate requirements set.

3.5.2 Communicating with the Stakeholders

The management of the relationship with the stakeholders all along the process of requirements acquisition, requirements analysis and specification is crucial because they represent the main addressers of the communication conveyed by the web site-to-be.

The communication with the clients and main stakeholders has multiple objectives, and their relevance varies according to the role played by the stakeholders. The project team needs to involve the clients and main stakeholders in an ongoing dialogue aiming at learning, discovering, creating, analysing and validating requirements. General cognitive biases and problems of this complex communication have already been investigated [Brown, 2002]. Let us here consider some important objectives of this communication, especially relevant for website development.

3.5.2.1 Prompting Needs and Goals

Stakeholders are often unaware of their communication needs and of what a web site is capable of providing to them. As a consequence, it is difficult to elicit the goals of the website from the clients, because goals may be articulated only after the needs are clearly identified.

Let us consider the following case. A client who is a rare web user wants a website. Somebody told him that if s/he will not have a website, his/her company will be eventually a step aside. This client have an extremely vague idea of what a website is, what kinds of services might be provided and what the user can do with it.

Moreover, there is no awareness of the actual need a website may contribute to satisfy. In this case, the role of the analysts is to *suggest* to the client possible scenarios in which a web site might be useful for his/her business. Prompting goals and needs is essential to clarify the benefit of undertaking a project and spending resources for a technological artefact like a web site is. In this context, examples of other existing websites in the same business, proper explanation of what the users might do with such web services, and examples of benefit for the company may be extremely useful to disambiguate a distort and vague image of the requirements for the website.

Whenever the client is able to express clearly predefined needs for having a website, the work of the analysts is facilitated. However, whereas in traditional information system development stakeholders seem to have a better understanding of the goals they want to achieve then they do the functionality of the system [Antón, 1997], for web site development the opposite happens. Stakeholder often tend to focus on detailed features of the website (maybe appealed by some other websites), rather than expressing goals and problems to be addressed.

In this case, analysts should inquiry about the reasons for the needs and expectations claimed by the clients, and articulating together with him/her possible goals the website might contribute to fulfil and examples of strategies to achieve them.

In both situations, stakeholders are the major source for negotiating the high-level objectives and the success criteria of the website.

3.5.2.2 Negotiating Constraints

An important aspect of the communication with the clients is the negotiation of the general project constraints. By general constraints we means the boundaries of the project activity set by the contract holding between the client and the project team, the technological means available, the time-to-market, and the resources to be spent.

Contractual, technological, financial and temporal constraints determine the context from which the requirements analysis starts, and to which it has to refer all along the lifetime of the project. The work of the analysts is to obtain *consensus* about a good-enough solution of the constraints that is acceptable by clients and project team.

3.5.2.3 Discovering other Relevant Stakeholders

Main stakeholders have often institutional or informal relationships one with another. Thus, during a meeting with a stakeholder, analysts may discover that there are other unexpected stakeholders to take into account, who had not been previously considered as relevant. This may happen for a variety of reasons. Analysts may not have sufficient domain knowledge to address the right questions to the right persons. In this case, the relationship with the stakeholders becomes explorative in a first stage, with the aim of discovering new persons in the picture.

In case of large projects, analysts incrementally get a complete picture of the stakeholders and their relevance as the project goes on. It may also happen that the stakeholder intentionally redirect the analysts to other stakeholders (e.g. representatives); in this case, analysts should understand whether this "delegation" of responsibility is due to a lack of knowledge of the former stakeholder, or to a reluctance of taking decisions and responsibilities.

3.5.2.4 Acquiring Domain Knowledge

Stakeholders are the major source for analysts to know the domain of the project (e.g. how the communication of a museum works for a museum web site, the mission and the institutional environment of a institution for an institutional web site). The process of acquiring domain knowledge is incremental as requirements elicitation, analysis and validation goes on. However, it is an ongoing process concerning also design (as to the content) and evaluation (as to the potential users).

Even if requirements analysis is not supposed to document all the domain knowledge (often tacit and hard to explicit), analysts should exploit stakeholders in order to know as much as relevant information as possible as to the business and communication environment.

Relevant domain knowledge is important for the project team to make informed decisions and to save meetings with stakeholders. Stakeholders are crucial gateways to this knowledge that would be otherwise hardly accessible by analysts.

3.5.2.5 Learning about Users

Stakeholders may help analysts to understand the target audience of the web site because stakeholders have the knowledge to state to whom their current communication is addressed. For example, B2B e-commerce web sites are addressed

to people who already do business together by other means, or even to new persons but still in the same business. In this case, clients know their business partners (their habits, preferences, and interests), and may help analysts to define specific requirements for the intended target audience of the site.

The more the web site is addressed to a well-identifiable population *niche*, the more the role of the stakeholders is crucial in clarifying user needs and profiles. In other cases, stakeholders may be able to identify only one portion of the users, usually the one corresponding to the current clients of their business. Task of the analysts is to highlight the potential of targeting new types of users for the website. For example, the web site of a famous museum is surely a communication tool for the museum to communicate with their potential visitors (e.g. families, students, or teachers). However, the website may be conceived also for accommodating the tasks of journalists and media that need to gather information and news about the institution.

The information that may be elicited by main stakeholders about the intended users may concern the habits, the knowledge, the preferences and practices of the users. This information may then be used for the analysis of user requirements (see chapter 3.4).

3.5.2.6 Validating Requirements

Stakeholders represent the only counterpart with whom to validate whether their needs and goals have been adequately interpreted and taken into account during the process. Validation concerns not only the adequacy of the strategy chosen, but also checks of understanding. After an elicitation session, analysts may document what they have understood about the requirements, and then go back to the stakeholders to check whether or not what they caught is actually what the stakeholders meant. In this way, analysis may commence on an agreed basis of material. Iterating in these activities (elicitation, analysis, documentation and validation) helps analysts and stakeholder mutually clarify goals and needs and to build an agreed picture of the requirements.

Periodical validation of the requirements is important to keep the designs aligned with the requirements. However, validation may risk to lead to “project creep”, that is the continuing evolution of the needs, desires and goals of the stakeholders as the project goes on. To manage this situation, the validation of the requirements with the stakeholders should always take into account the general project constraints negotiated (see 3.5.2.2).

AWARE is not intended to state universal rules to manage the communication with the stakeholders because the irreducible complexity and the variability of this relationship makes it still to be largely an ad-hoc process. However, a model may highlight some factors to consider during the communication with the stakeholders.

3.5.3 Client's and Main Stakeholders' Goals

What do main stakeholders want to achieve by means of the site? What are the goals of the communication through the website? What return on investment (in term of brand awareness, image, new contacts, new clients, revenues) do they expect to gain?

The answers to these and other questions determine the actual reasons why a web site exists. Stakeholder goals may be different from user goals. Let us consider a simple example. In the case of a famous online bookstore, whereas a goal of the user is to purchase a specific book at the lowest price possible, the goal of the site strategists is to bring the user to purchase as many books as possible. Ideally, both goals should be satisfied. Therefore, site requirements should consider both goals, and inform design decision accordingly.

High-level stakeholder goals may be dictated by the business model underlying the site [Rappa, 2003]. On the basis of a business model, communication goals may also be pursued.

Goals are defined as high-level targets of achievement for the stakeholders. For a university website, high-level goals of the university stakeholders may be:

```
a)Attract new students to the university
b)Provide interns with easy-to-reach resources
c)Promote an innovative and professional image
d)Attract new research partners
```

It may be argued that part of the main stakeholders goals concern the satisfaction of the users. In the example, goal b) represents the wish to serve internal personnel (such as students, secretary, faculty staff) with resources useful to their everyday tasks (such as lesson hours, course program, room allocation). As such, a goal of the stakeholders may aim at satisfying goals of the users. In this case, analysis of goal b) should be carried out assuming the perspective of the potential users (students, faculty staff, secretaries) using the tools provided in 3.4.

Let us consider another example. In a web site for a city hall, the key mission of the city hall website is to allow citizens accomplishing administrative tasks through the

site in an efficient and satisfactory way. Is this actually a goal of the city hall, or a goal of the potential users of the web site? On one hand, this goal is part of the mission of the city hall; on the other hand, it is also a wish of the user while using the website. Also in this case, the user perspective has to be adopted to analyze user goals (even if these goals are dictated by the mission of the city hall), and deriving appropriate requirements.

When asked what are the objectives of the site-to-be, stakeholders often express what they would like to offer to the user: "we allow the user to subscribe to this service, to see our activities, and to contact us". They predicate tasks on the users rather than clarifying their own objectives.

Distinguishing as clearly as possible between goals that are owned by the users (*what might the users want to do through the website*) and goals that are owned by the main stakeholders (*what do the stakeholders want to achieve by having the website*) – although they are often intertwined – enables to clarify the reasons why the website should exists (goals of the main stakeholders), and what are the benefits for the user (goals of the users).

To this end, AWARE introduces the concept of client scenario.

3.5.4 Client Scenarios

The two kinds of viewpoints on the goals of the website, the one corresponding to the user perspective (user goals), and the one corresponding to the client perspective (clients' and main stakeholders' goals) may be elaborated by specific conceptual tools. In 3.4.2, we have seen how to make use of *user scenarios* to elicit and model user goals. User scenarios represent, at different levels of abstraction, a vivid narrative of a potential visitor of the website in a concrete circumstances of use. In other words, user scenarios highlight the intentions and goals of the users.

Client and main stakeholders have their own expectations with respect to the behavior of the user. Clients want the user to do preferably certain tasks, rather than others. For example, a stakeholder of an e-commerce website wants the user to be attracted by the latest offers, and to consider seriously to purchase them. Specific requirements may descend from this wished scenario: latest offers will be designed as attractive as possible, together with appealing slogans. Access to these products will be highlighted as much as possible in the overall site structure.

This is an example of a *client scenario*: it is not driven by a wish of a user, but rather by a goal of stakeholder. Whereas a user scenario describes what a user might

want to do with the website, a *client scenario describes what clients and main stakeholders want the user to do on the website*. In other words, client scenarios are the reification of how the stakeholders would like the user to behave on the site. Client scenarios express ideal uses of the web site, and may help analysts, stakeholders and designers reflect and consider novel requirements.

In most cases, scenarios are employed as success stories (except for scenarios aiming at highlighting unexpected behaviors). Whereas the success of a user scenario is assessed with respect to the satisfaction of a user goal, the success of a client scenario is assessed with respect to the achievement of a client or main stakeholder goal,.

To highlight the distinction between a user and a client scenario, let us consider the following client scenario, to be compared with the user scenario for the requirements analysis of the museum website recounted in 3.4.2:

A high school art teacher connects to the web site to check what the munch exhibition is about and she is struck by the artistic relevance of the works of art exposed. As she explores more and more works, she is increasingly interested in visiting the museum and participating to the events organized by the museum. Checking for the future events at the museum, she is attracted by the event sponsored by the "Munch Association" about Munch's art and life, and she books a ticket for it. After purchasing the ticket, directly from the site, she has the possibility to recommend to a friend (sending the event page with a customized message) about the event she will attend.

In 3.4.2, we have seen that user scenarios may help elicit, analyze, exemplify, and render more concrete user goals. Analogously, client scenarios help elicit, analyze, exemplify, and render more concrete the goals of the client and main stakeholders' so as they may influence the user experience.

In case of a university website, considering the high-level goals identified in 3.5.3, a possible client scenario is the following:

John is a foreign high-school student who is deciding where to enroll for his bachelor degree. He is interested in computers and Internet and is exploring several university website to find the faculty most suitable for his interests and requisites. He comes to the Univ_X website and read the overall presentation of the faculty. He browses the list of the courses offered and he is astonished by the assortment of different disciplines covered by the program. Reading the presentations of the bachelor program in Communication Sciences, he finds out he might learn not only computer-related stuff but also have a wide background in communication, and in the use of technology for different areas of communication, which are competencies more and more valuable today on the job market. The highly regarded academic quality of the faculty member and the beauty of the venue where the

university is located also strike him. He checks out for the fee and the possibility of obtaining finance support. Then, reading that the pre-subscription deadline is approaching, he fills in the pre-subscription form.

Both kinds of user and client scenarios may be created, negotiated and discussed with the clients and main stakeholders. However, whereas user scenarios may also be created together with user representatives, by means of focus group sessions, interviews, and surveys, client scenarios are preferably created together with the client and the main stakeholders.

Both user scenarios and client scenarios should be defined and taken into account by the analysts to elicit a broader set of requirements to consider.

3.5.5 The Role of Assumptions

Client and main stakeholders goals with respect to the website may emerge from a heterogeneous set of domain knowledge which is difficult to capture and unfeasible to document in its whole in the requirements specification.

For example, highest-level business goals of the organization or the institution (e.g. to make or not to make profit) are to be considered assumptions for the requirements analysis. Analysts should rely on these assumptions, and investigating operative communication goals with the respect to the website-to-be. Similarly, current communication practices, policies, laws and regulations should be carefully taken into account by the analysts; however, analysts are not necessarily supposed to explicitly document all this knowledge in the goal analysis.

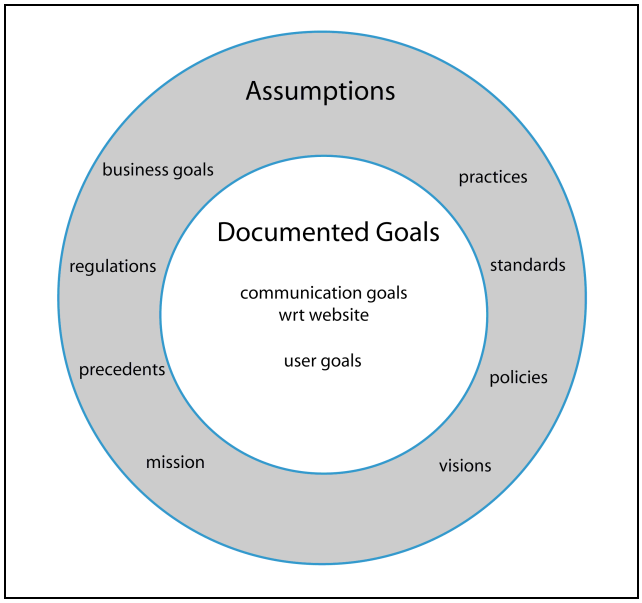


Figure 17. Assumptions and documented goals in website requirements analysis.

The risks of documenting all the assumptions in the requirements analysis are the following:

a) *analysts are not domain expert*: arguing and making hear his/her voice about high-level business goals, specific policies, regulations and long-standing practices is not his/her task. Doing that, it would be unfruitful for the sake of the analysis and would risk denigrating the competence of the analysts at the eye of the stakeholders.

b) Documented goals should state the *novel* strategies negotiated with the stakeholders with respect to the website-to-be. Spending resources in documenting what the stakeholders already know is not supposed to be part of the web site requirements analysis and would risk to overlook the distinctive communication goals of the website.

c) Only those assumptions should be kept in mind and documented that are crucial and salient for giving reasons of certain goals and requirements, or justifying design decisions. Other domain knowledge that is not specifically relevant for the analysis will only cause problems and waste of resources.

Goals of the stakeholders may also be non-functional or *softgoals*. Softgoals (see 3.4.3) correspond to the statements of high-level non-functional requirements, such as usability, security, reliability, efficiency. Whereas some of these non-functional may be crucial to document and to operationalize carefully in the analysis, others are really too

vague and trivial to be stated at a high-level of abstraction. For example, it is obvious both for the analysts and for the client that the site should be *usable*. The problem is how to translate this high-level wish into a usable design, not to obtain consensus about whether or not the site should be usable.

On the basis of the assumptions, those goals concerning the communication strategies of the clients and of the main stakeholders with respect to the website are fully documented. Moreover, user goals emerging from the domain knowledge will also be part of the documentation of the analysis.

3.5.6 Priorities

Clients and main stakeholders may be several, as well as their respective goals and expectations for the site-to-be. Like user modelling, priorities may be introduced for managing and organizing the complexity of the whishes of the clients and main stakeholders.

Like for the modelling of user and their goals, AWARE recognizes the importance of prioritizing stakeholders and their goals [Moisiadis, 2002]. To this end, specific priority concepts are associated to goal-driven analysis.

In particular, three priority tools are presented in the next paragraphs: *stakeholder priority*, *stake priority*, and *goal priority*. They express different aspects of the prioritization of website goals, and should not necessarily used in concert. Analysts may select one or more priority techniques most suitable and useful for the project at issue.

3.5.6.1 Stakeholder Priority

Project team may need to decide internally which clients and main stakeholders are more important to consider than others, because of organizational reasons, or because of business or communicative purposes.

A *Stakeholder Priority* may thus be associated to each stakeholder (user profile, client, or any main stakeholder) in order to help analysts weigh properly the goals and the needs expressed by each stakeholder, and consequently plan effort and resources for the analysis in a more efficient way. For example, analysts may decide to take into account more the opinion of the decision makers of the organization rather than the ones of other representatives.

Stakeholder priority may used not only to express the *absolute importance* of stakeholder from the perspective of the analysts, but also the *relative importance* of a

stakeholder from the point of view of another stakeholder. For example, the client may consider user profile_1 (e.g. tourist) more important to consider than user profile_2 (e.g. teacher) (see 3.4.9). Or, a client may suggest that the opinion of one client representative is more important than the one of some other stakeholders.

3.5.6.2 Stake Priority

A stakeholder may consider a goal more important than another. For example, the director of the museum may consider more important to maintain a highly regarded image of the museum, rather than promoting sponsors' brands. As suggested by traditional elicitation techniques, analysts may gently "force" stakeholders to prioritize their goals, so to make the project converge to crucial application objectives.

The relative relevance of a goal for a given stakeholder is expressed by the *Stake Priority.* In this sense, each stakeholder viewpoint projects on the goals its own priority perspective. The stake priority may also justify how much a stakeholder is willing to invest (e.g. in term of money for the organization or in term of "interaction energy" for the user) to accomplish that goal.

3.5.6.3 Goal Priority

Stakeholders and the project team may also agree on considering some users' goals more improbable to happen rather than other, or more crucial to support rather than other. The *Goal Priority* it expresses the absolute importance of a goal in the overall economy of the analysis. Goal priority may be set from the outset or may be derived by taking into account the different stake priorities and the different stakeholder priorities.

The use of priorities – that is still under exploration and validation- becomes more and more relevant as their propagation on the website requirements will be addressed. In the next chapter, as we see how to translate the goals into requirements for the website, we will also address the definition of requirements priority.

3.6 From Goals to Website Requirements

Like existing goal-based approaches to requirements engineering (see 2.2), AWARE adopts a *refinement process* to pass from high-level goals of the stakeholders to subgoals and eventually to website requirements.

In website development, the raw material gathered during elicitation (from user composite profiles, from clients and main stakeholders) may consist of an unstructured mix of very high-level goals, scenarios, pieces of design, examples of other sites, design ideas and sketches, design decision, and detailed requirements. These first set of raw material emerged during elicitation should be somehow organized in order to be usable by the analysts, and fed into design.

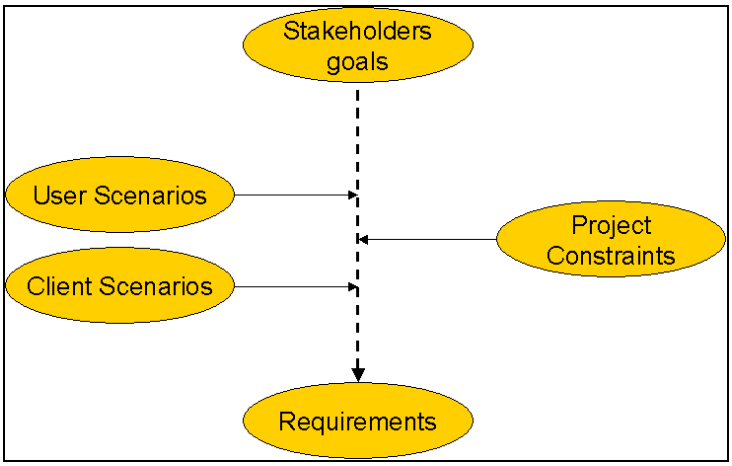


Figure 18. Some salient factors influencing the goal analysis process.

Taking into account the constraints of the project (such as the resources available, in terms of budget and time to market), analysts should be able to organize the elicitation material, and iteratively devise proper requirements for the website-to-be.

To this end, goal-oriented requirements techniques suggest building a means-end hierarchy of goals by investigating *Why* and *How* for each goal encountered in the analysis.

3.6.1 How Questions: The Refinement Process

User composite profiles, clients, and main stakeholders provide goals and tasks at different levels of abstractions, because the material emerged during the early requirements phase (elicitation through brainstorming and interviews with stakeholders) have different granularity and scope.

Given a goal in the user composite profile, the structuring process is guided by a basic question: *How can this goal be satisfied?*

This is neither an abstract nor a trivial question, because it involves a decision-making process for the communication strategy that will be implemented by the site. This is the activity in which analysts make the most important strategic decisions about the application.

The answer to a *How* question identifies a subgoal for the upper goal. Iteratively, *How* questions enable to refine subgoals into further sub-goals and eventually into application requirements.

The refinement process is supported by the definition of salient user and client scenarios, which may help uncover new requirements, goals and stakeholders, exemplify goals, and assess the derivation process [Bolchini, 2002]. The answer to *how* questions should always be realistic, that is properly balanced with the constraints of the project, the priorities, the time and the budget available.

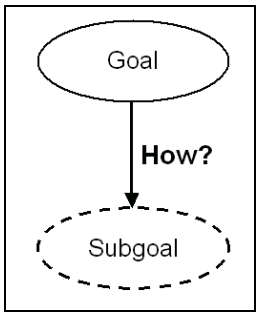


Figure 19. The goal refinement process.

The refinement process should be seen as an iterative process of identifying a sufficient (not necessary) strategy to satisfy the upper goals.

Note that the refinement of a goal into a subgoal is not an absolute (or necessary) relationship, but it is relative to the project. In fact, a refinement link and the relative subgoal are decided with respect to the resources and scope of the project.

In RE literature, the refinement of goals into subgoals is also called *derivation* or *operationalization*. These terms are used in contexts where requirements can be almost calculated from goals in a necessary way. For example, in the KAOS approach (see

2.2.4), system goals may be broken down into subgoals and analysts are able to demonstrate why a set of subgoals satisfies the upper goal.

However, as recognized by the NFRs framework, goals may not have a clear-cut criterion for their satisfaction. It cannot be demonstrate with an algorithm why a set of subgoals satisfies the upper goal. It is only possible to provide arguments and to find an agreement on the fact that the strategy chosen is reasonable and seem to be effective.

Consider the following example of refinement for a client goal.

Let us assume that one of the goals of the communication director of an internationally famous museum is to use the website to `Educate people to understand modern art.` How can this goal be achieved? A possible strategy, taking into account the content, the time, the resources available, and the preferences of the stakeholders, is to decompose this high-level goal into three main subgoals:

- Subgoal 1: `Stimulate interest in understanding modern artworks`
- Subgoal 2: `Offer explanation of a selection of modern art works in a familiar and easy way`
- Subgoal 3: `Attract users to the real museum to get a in depth experience`

Each of these subgoals may be further refined and analysed, by identifying proper subgoals that may contribute to its fulfilment. In AWARE, the relationship between a goal and a subgoal is a relationship of *contribution to fulfilment*. In other words, a subgoal does not necessarily *satisfy* the upper goal, but rather *satisfices* it (see 2.2.5).

3.6.2 Why questions: The Traceability Process

Whereas *How* questions help organize and analyse the material of the elicitation towards the identification of requirements, *Why* questions aim at investigating the reasons why given requirements, goals, or designs have been defined. For each artefact identified, analysts should wonder: *Why* does the user/main stakeholder want to achieve this goal?

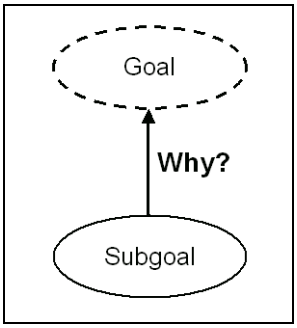


Figure 20. Goal traceability process.

Why questions enable abstraction of low-level tasks into higher-level goals and point out lack of rationale for given goals. *Why* questions may investigate artefacts at any level of abstraction from goal, to requirements, and to design pieces.

Traceability is extremely relevant for web project teams because it allows keeping a trace of goals that may quickly evolve along the development cycle. It is known that stakeholders (users included) often change their mind about their needs and goals due to an evolving understanding over the lifetime of the project. Under these circumstances, record of the decision about goals help negotiate with the stakeholders and manage evolving requirements.

In the museum example, if the analysts have to cope with a requirement such as "provide high-quality image of each painting", it is reasonable to wonder *why* this requirement has been defined. If it is derived by a previous refinement activity, it is easy to trace back the reason for it. Otherwise, it would be better to ask stakeholders and the project team. Reasoning about that requirement, a salient scenario may be envisioned and validated together with the main stakeholders to give reason for that requirement.

The refinement and traceability activities do not necessarily prescribe any top-down or bottom-up process, but they rather capture two different aspects of an iterative, parallel, and incremental analysis of the material gathered during the elicitation, with the aim of organizing and structuring it. In goal-oriented RE, this goal structuring activity is also called "laddering".

3.6.3 Goal Graphs

As common practice in goal-oriented requirements engineering, the hierarchy of goals may be structured in a *goal-graph*. Like in *i**, the roots of the graph are not high-level goals, but rather the stakeholders who own those goals. The second level of the

graph is made by the goals owned by the relative stakeholders. Subgoals are represented as a third level, and so on following a means-end criterion.

A complete graphical notation of AWARE goal-graph is presented in Annex I. In this chapter, for better separating the semantics of the AWARE constructs by the possible graphical representations, we introduce general issues in goal analysis addressed by AWARE without committing on a specific graphical notation. The notation shown in the examples discussed has been excerpted from heterogeneous project works, and it is therefore neither consistent nor definitive. It may help give a idea of the concepts discussed.

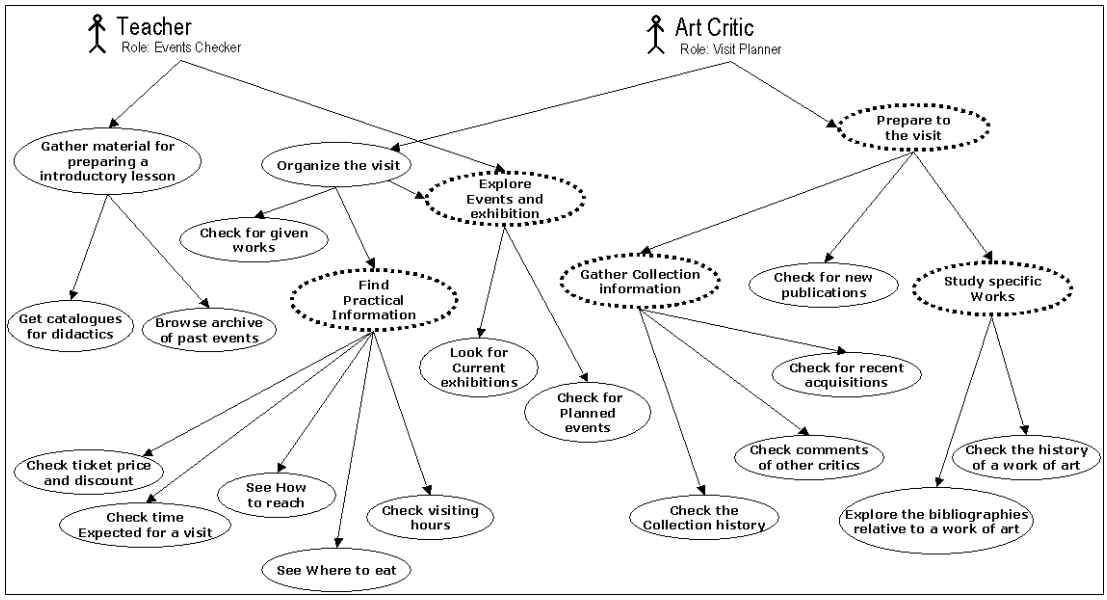


Figure 21. Example of goal structuring.

Structuring goals by *Why* and *How* questions allow build a goal graph like the one shown in Figure 21. This example represents part of the analysis of the goals of the user composite profile for the web site of exhibition of Munch's prints in Berlin (see 3.4.11). The goals defined in the user composite profiles are reported and structured in a means-end hierarchy. On one hand, goals have been decomposed into lower-level goals. On the other hand, whereas enough rationale for given goals was missing, new higher-level goals have been defined (dotted circles) at this stage.

3.6.4 Identification and Granularity of Requirements

AWARE extends the classic goal-subgoal structure to the elaboration and definition of hypermedia-specific requirements. In this sense, the idea of introducing requirements as refinement of higher goals is similar to the KAOS approach, where the operationalization of goals enables to specify a detailed requirements set. In fact, the refinement of goals should lead to the identification of the requirements. However, this is not necessarily the case. The objective of the requirements analysis is to refine and analyse goals to the point where the results of the analysis are usable to be fed to web designers. For example, in analysing user goals, it may happen that the goal analysis stops at the task level (or at the subgoal level in some parts), leaving up to the designers to interpret these tasks or subgoals and create suitable design solutions to support them.

However, it may also help designers to have a detailed set of requirements, possibly expressed at a proper conceptual level.

Requirements are the leaves of the goal graph. Whereas a goal is a wished state of affairs for a stakeholder, a requirement describes a desired functionality of the website-to-be that may contribute to satisfy one or more stakeholder goals.

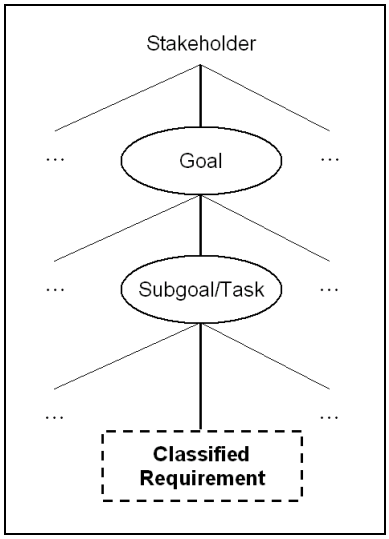


Figure 22. Deriving requirements from goal analysis.

To facilitate the organization of the design activity, requirements are classified according to the design dimension they have an implication on. The list of design dimensions is fully described in 3.7.

For example, analysing the subgoals for the museum website presented in 3.6.1 some of the following requirements may be defined:

- `Provide thematic guided-tour of works;`

- Provide high-quality visual details on demand;
- Provide plain description of each work;
- Relate each work to information about the author;
- Highlight detailed opening hour, visits availability and contact information;

It has been acknowledged that there is no "the" proper level of abstraction by which requirements should be defined [Robertson, 2001]. Since they are the result of an on-going and iterative negotiation between the analyst, the domain experts, the stakeholders and the designers, the granularity of requirements is strongly dependent on three variable factors:

1. Shared domain knowledge. It is the degree of implicit and shared understanding between the analyst and the web designer about the given domain. The more detailed is this knowledge, the less information should be explicated and specified in the requirements definition.

2. Designer Experience. Web designers with a long-standing experience can easily figure out how to transform ill-defined and generic requirements into effective design solutions. Less-experienced designers should be helped in achieving a proper solution by very detailed requirement specifications.

3. The conceptual design tools mastered by the designer. The more a designer masters proper conceptual models, proven design methods and effective design patterns, the less would analysts need to provide him/her with detailed and low-level requirements.

AWARE suggest to define website requirements in natural language, striving for a healthy balance between expressing them *informally* (to allow stakeholders to understand and contribute), and as *unambiguously* as possible (to avoid misunderstanding).

3.6.5 Viewpoints on Goal Relationships

In RE, goals are usually decomposed into sugoals and eventually into requirements through AND, OR, or EXOR relationships. AND-decomposed subgoals have to be all satisfied to satisfy the upper goal. Either one of the OR-decomposed subgoals must be satisfied to fulfill the upper goal. EXOR-decomposed subgoals represent exclusive alternatives to be satisfied.

Who sets these relationships? Goal graphs should represent the outcome of a negotiation between analysts, stakeholders, and designers. However, it is not always clear *from which point of view* goal relationships are defined.

Let us consider an example taken from the reverse goal-analysis of the Toronto music week website. The Toronto music week is a week of musical events and concerts all over the city of Toronto. For the web site promoting the music week, the analysis of possible user goals from the stakeholder (user) perspective, may bring to state that a tourist who never attended the music week in Toronto might want to `be helped select interesting events to attend` during the week. According to the user point of view, this high-level goal may be OR-decomposed in three subgoals: the tourist might want to `See where Genre X is played`, or he might want to `See where band X plays`, or s/he might just want to `Get an idea of what's up.`

From the analyst/designer point of view, this decomposition may have a different meaning: *all* three scenarios must be supported by the site. The user should be able to `See where Genre X is played` *and* to `See where band X plays,` *and* `Get an idea of what's up`, right because all three goals represent three plausible and salient user goals.

Therefore, an OR relationship for the user perspective may be seen as an AND relation from the designer perspective. Both perspectives are correct and reasonable. However, it should be clear which point of view is chosen to express the relationship.

As shown in the example, goal relationships assume a different meaning according to the point of view they are expressed from. In particular, AND-OR operators - when applied to goal graph - may have two meanings according to two main viewpoints: *the stakeholder's viewpoint*, and *the designer/analyst viewpoint*.

The perspective of the stakeholder addresses the question: *How may the stakeholder achieve a goal?* In this case, AND-decomposition means that the stakeholder needs to achieve all subgoals to accomplish the upper goal. Analogously, OR-decomposition means that it is sufficient for the stakeholder to achieve at least one subgoal to accomplish the upper goal.

The perspective of the designer/analyst addresses the question: *How may the design support stakeholder's goals?* According to this point of view, AND-decompositions means that the design will support the achievement of all the subgoals; whereas OR-decomposition defines each subgoal as leading to a high-level design alternative.

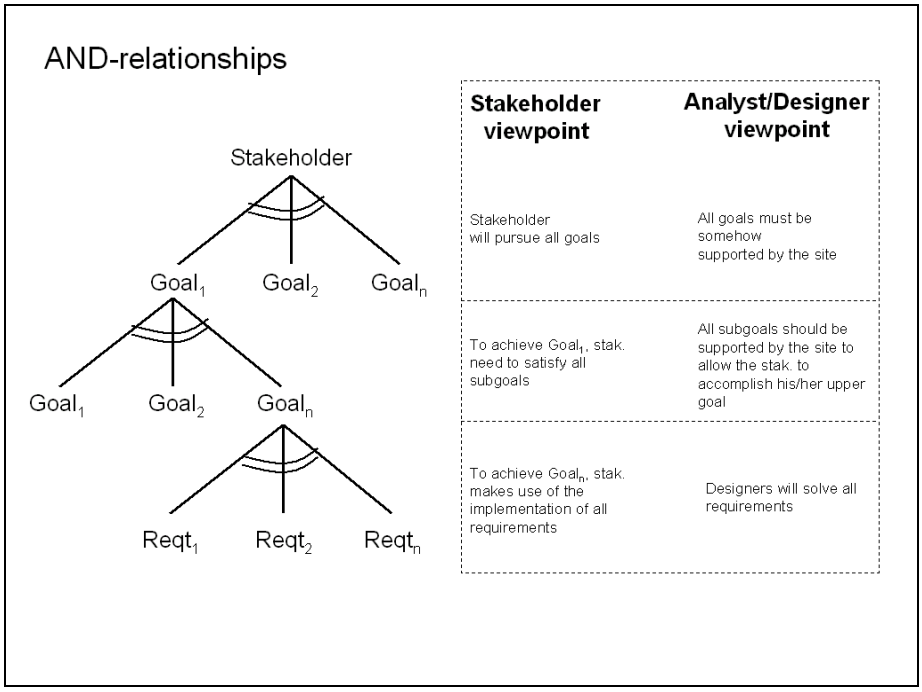


Figure 23. Meaning of AND decomposition according to different viewpoints.

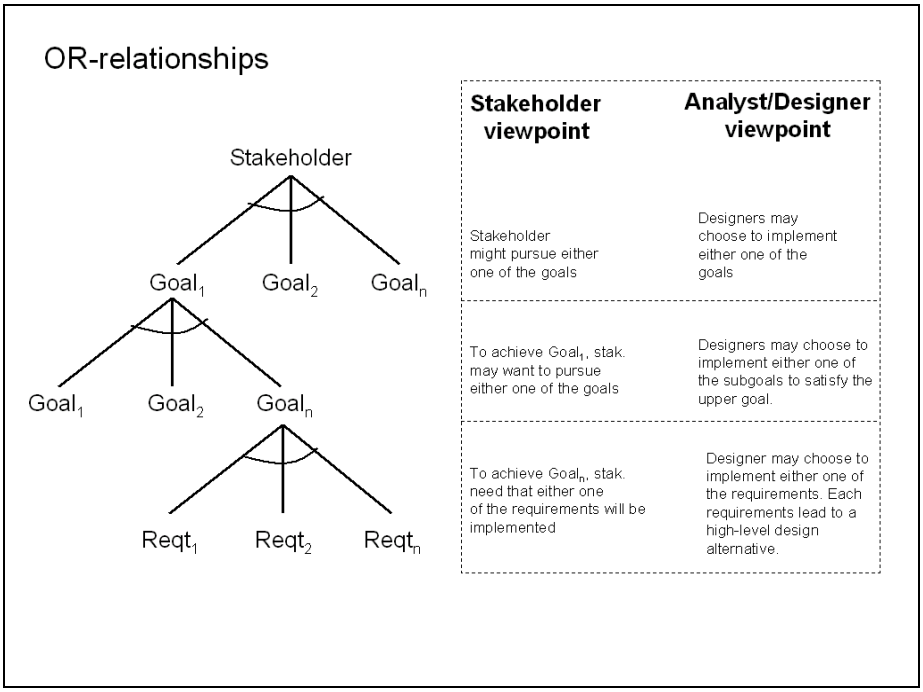


Figure 24. Meaning of OR decomposition according to different viewpoints.

Differences in the point of views on goal relationships may be propagated at any level of abstraction of the goal graph (see Figure 23 and Figure 24), from the stakeholder to the website requirements.

Considering the process of goal analysis, the stakeholder perspective may be used in the early stages of requirements analysis. The designer perspective may be assumed at a later stages, as the material of the analysis is assessed enough to be treated as input for the design activity.

3.7 From Requirements to Conceptual Design

Requirements are the input for the design activity. Web application design is a complex task, which involves several skills, different persons, and addresses a variety of aspect of the application.

Requirements may be classified according to the application aspect they concern, in order to better organize the design activity. Especially in large projects, as the number of requirements is growing, proper classification of requirements allows setting an order in the requirements set and rationalizing the gathered material.

To classify requirements, taxonomies may be introduced. In this context, a taxonomy is a list of concerns pertaining one or more requirements at issue. Taxonomy may vary from domain to domain and from family of web applications to family of web applications.

AWARE provides a specific taxonomy for organizing *hypermedia requirements*, i.e. those requirements that are crucial to identify and address in content-intensive web applications.

In the current RE research, the analysis of hypermedia requirements is not systematically covered in requirements analysis concerns. However, their relevance is growing. Cultural-heritage web sites, educational web sites, institutional web sites, promotional and corporate web applications, and even a large part of e-commerce web sites are just a few examples of domains in which sites are designed first and foremost as means to communicate content and also as a tool for accomplishing operations and transactional tasks [Bolchini, 2003b].

As it will be explained, new and various taxonomies can be defined. For example, security and privacy requirements may give raise to a distinct taxonomy to be considered for web applications where these concerns are really important.

The hypermedia taxonomy itself, which is presented in the next paragraph, is under assessment, as well as open to revision, modification, and extension.

3.7.1 Hypermedia Requirements

In order to organize the hypermedia requirements set and facilitate the design activity, a hypermedia *design dimension* is assigned to each requirement. A dimension expresses the application design aspect each hypermedia requirement will have an implication on. The hypermedia requirement taxonomy comprises so far the following dimensions [Bolchini, 2003b]: *Content* (labelled with C) , *Structure of Content* (labelled with SC), *Access Paths to Content* (A), *Navigation* (N), *Presentation* (P), *User Operation* (U), *System Operation* (O), *Interaction* (I).

3.7.1.1 "Content" requirements

Content - the core value of a web application - refers to that set of ideas and messages that the site communicates to its users. Ideas and messages are mainly specified in term of information chunks provided. In the case of a museum web site, content requirements might be: "present details for each painting", provide bibliography for each painter", "present museum collection history", "provide director's welcome", "communicate opening and visiting hour".

3.7.1.2 "Structure of Content" requirements

Requirements can also give coarse-grain insights about how the content pieces identified might be structured. By "structure" is meant the organization of the content. Providing initial requirements about the structure of content means expressing the need of highlighting particular pieces of content or messages within an information object. In the museum example, such requirements might be: "in the museum presentation, highlight the historical value of the building", "presenting the painting, detail the techniques used".

3.7.1.3 "Access Paths to Content" requirements

This dimension refers to the navigational paths available to the user in order to reach the needed content. The user should be allowed to access the needed information or be guided in the exploration of the offered content following the navigational access paths best corresponding to his expectations and goals. This dimension captures the strategy

behind the hypermedia artefacts exploited by the user to start the navigation, to locate and reach the interested content. Thus, examples of requirements pointing to this design aspect are: “allow access painting by author”, “provide thematic guided tours”, “allow access authors by period and by name”, “provide access to recommended work of arts”, “guide through the paintings of the weeks”, “allow planning a visit by date and preferences”.

3.7.1.4 “Navigation” requirements

Requirements can suggest connections between different information pieces allowing the user to navigate from one piece of content to another. Semantic relationships among information pieces can be relevant for navigation, i.e. can be exploited by the user to traverse the path connecting one object to one or more others in order to complete his cognitive or operational task. This design dimension captures the hypermedia artefacts exploited by the user to navigate, once accessed a given information object, from that object to one or more others semantically related. Examples of navigation requirements are: “relate each painter to its author”, “relate visits information to restaurant and hotel services available”, “relate history collection to most precious work of arts”, “and relate information about an artistic movement with its representative authors”.

Other types of navigation requirements may be related to the technical architecture of web application as far as it may influence the user experience. For example, a well-known issue in e-commerce website is the need for keeping aligned that status of the client with the status of the server. This is a technical requirement that may lead to specific navigation requirements. For example, the Amazon.com bug recounted in [Baresi, 2002] is due to a problem of non-compliance with this requirement: the user is about to process a shopping cart containing three items (that it what the browser displays), whereas the actual shopping cart stored in the server contains more items. Navigation requirements to fix this problem may be “to update the status of the shopping cart whenever it is retrieved”, or “remove non up-to-date shopping cart from the browser’s history”, or other navigation strategies.

3.7.1.5 “Presentation” requirements

Requirements can also give guidelines and design input for conceiving the visual communication strategies for presenting content, navigational capabilities and operations to the user. Presentation design concerns two main aspects: graphics and interface

layout. Graphics concerns the visual element composing the user interface (buttons, icons, images, font proportions, titles); layout concerns the physical positioning of these objects on the page. Examples of presentation requirements might be: “present a young style for teenagers in the Kids section”, “present a professional but artistically rich style in the collection layout”, etc.

3.7.1.6 “User Operation” requirements

User operations are those operations that are visible to users to complete some tasks. Roughly, these operations are all operations that users can trigger by interacting with the application. In the museum web site, examples are: “subscribe to a mailing list”, “create personal collection”, “post personal comment to a painting”, etc.

Let us imagine en electronic auction (such as e-bay.com): user operation requirements may be: “make a bid”, increase the bid”, remove the bid”, “accept current bid”, etc.

3.7.1.7 “System Operation” requirements

These operations that are not visible to users, but become mandatory to “build” user operations. Possible system operation requirements include: “force user authentication for building personal collection”, “track user navigation and build preference profiles”, “update recommendations every five user sessions”, etc.

3.7.1.8 “Interaction” requirements

These requirements describe envisioned styles of interaction for the user. In a museum of modern art, an interaction requirement could be to “provide the user with an interactive 3D model of a representative work of art” to raise her interest in understanding the modern art. Such requirements are obviously related to the presentation aspects; however, they capture application aspects that may need a specific design elaboration.

Although a requirement may concern more than one dimension, our project experience suggests that it is better to refine a requirement to the point where exactly one dimension can be assigned to it. If a requirement cannot be easily and clearly assigned to exactly one dimension, then it is still too general to serve as input for design and should be further refined. This separation of concerns facilitates the achievement of an agreed granularity level.

3.7.2 Classifying Non-Functional Requirements

Non-functional requirements concerning hypermedia aspects of the website can also be classified according to the AWARE taxonomy.

On the basis of a comprehensive classification of quality attributes for user interface design presented in [Chung, 2000], and on lessons-learnt from previous web project experiences, examples of hypermedia non-functional requirements may be: *Effectiveness, orientation, status visibility, predictability* for the navigational aspect (N) of the web site. Requirements such as *completeness, authority, currency* and *accuracy* may be relevant for the content aspect (C). *Clearness, Consistency* and *Perceived Order* may be considered for the presentation aspect (P). *Accessibility, Organization of Information* and *Learnability* may be classified under the access dimension (A).

3.7.3 Aspects and Other Classes of Requirements

There are also cross-cutting concerns[10] of web requirements that are not related to a particular service, functionality, or property of the web application but rather to its *management*.

In this sense, the management (e.g. update, maintenance, enhancement) of the website is an important and very practical *aspect* that might have to do with a variety of other requirements (navigational, structural, content-related, operational, etc). For example, a typical management requirements may be: “news should be updated every two weeks by Mr. Ross”, “the number of products to present varies of 10-20 unit every month, and product database should be updated by Mr. Feature”, “the mailing list will be activated after two month from the first release”.

These requirements can be generalized as follows: requirement X (concerning any of the hypermedia dimension defined) is to update every T period (by person P). As such, the management aspect identifies requirements that are predicated on other requirement. Moreover, the definition of proper workflows (within the organization or the institution

[10] From a general requirements engineering perspective (not specific for web applications), in [Rashid, 2002] may be found an initial definition of a framework for modelling cross-concerns requirements called “aspects”.

running the website) and responsibilities for updating the content, maintaining and enhancing sections are important aspects to consider in contexts of evolving requirements[11].

Requirements pertaining to customization represent another aspect cutting across various types of other requirements. Navigation requirements, content requirements, access, requirements, presentation requirements may all be influenced when customizing the design of a web application for ubiquitous delivery or personalization [Rossi, 2001].

There are a variety of other classes of lower-level requirements. For example, requirements concerning the *technical architecture* on which the web applications will run (e.g. server performance, database systems, transaction engines, distributed environments) may influence the analysis. Requirements for web applications characterised by a pure *transactional* paradigm may also be considered. Requirements concerning the enforcement of *privacy* and *security* policies are also relevant. *Accessibility* requirements may also be important to model and take into account for impaired individuals.

All these additional classes of requirements go beyond a purely hypermedia taxonomy. As such, these issues are not central to the current version of AWARE presented in this work, but they are part of future research effort.

The AWARE hypermedia requirements taxonomy is obviously open and always revisable. Emerging web applications may call for ad-hoc types of requirements that need to be captured early in the analysis (e.g. multi-channel applications, web-based collaborative 3D environment) and may suggest new dimensions to be considered.

3.7.4 Defining the Requirements Set

Although a requirement may concern more than one dimension, our project experience suggests that it is better to refine a requirement to the point where exactly one dimension can be assigned to it. If a requirement cannot be easily and clearly assigned to exactly one dimension, then it is still too general to serve as input for design and should

[11] Note that management requirements should be better treated from the perspective of the current practices and tools of project management.

be further refined. This separation of concerns facilitates the achievement of an agreed granularity level.

Now that we have investigated the relationship between stakeholders, goals and the types of requirements that may be defined all along the goal analysis, it is useful to take a look at full derivation chain.

Figure 25 is the prosecution of Figure 21. It shows the goal graph representing the outcome of the refinement process from the high-level goals of the user composite profiles identified for the museum website until the definition of the requirements, properly classified according the hypermedia taxonomy.

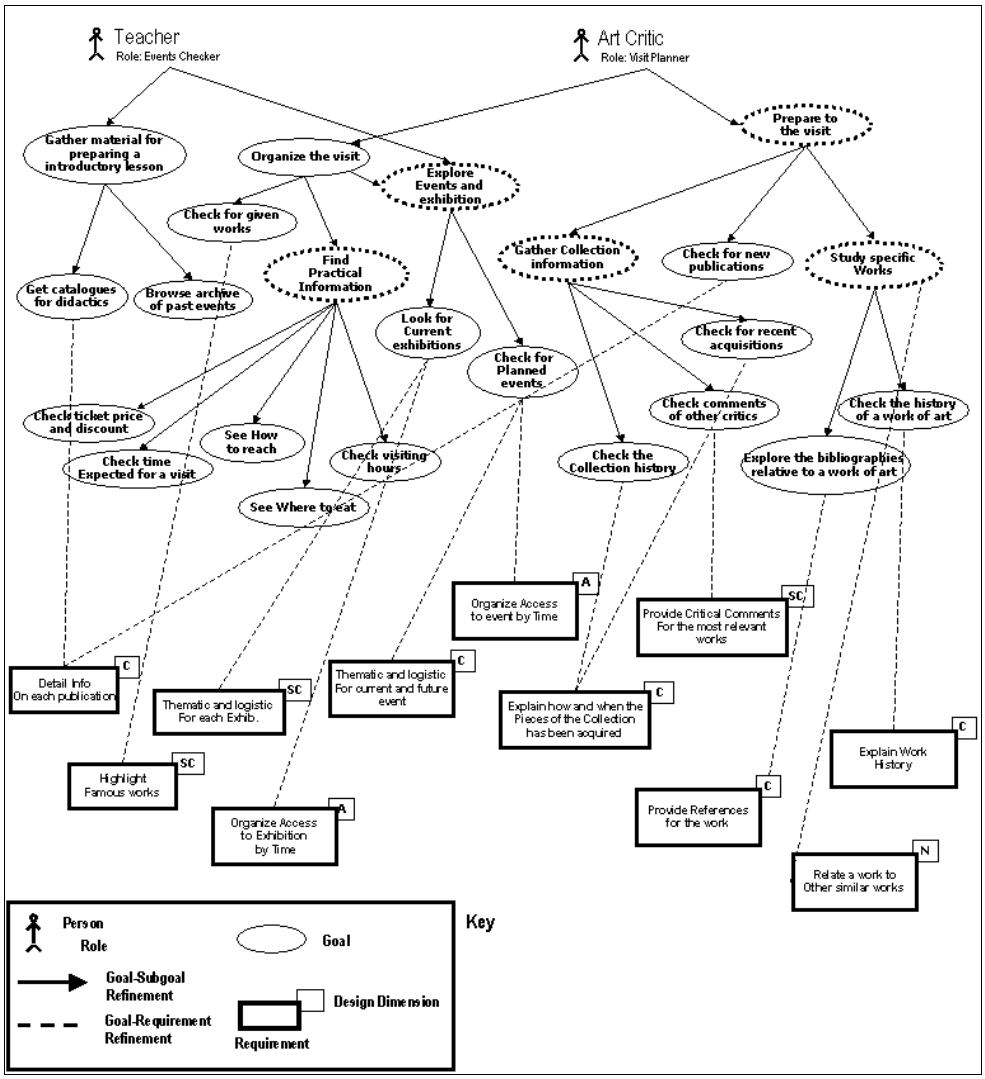


Figure 25. Excerpts of goal refinement towards hypermedia requirements, labelled according to the hypermedia taxonomy.

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 web conceptual design (e.g. WebML [Ceri, 2002], OOHDM [Schwabe, 1998], HDM [Garzotto, 1993], RMM [Isakowitz, 1995], WSDM [De Troyer, 1997], EORM [Lange, 1994], UML for the web [Baumeister, 1999], or W2000 [UWA, 2001c]) to shape design solutions solving the requirements.

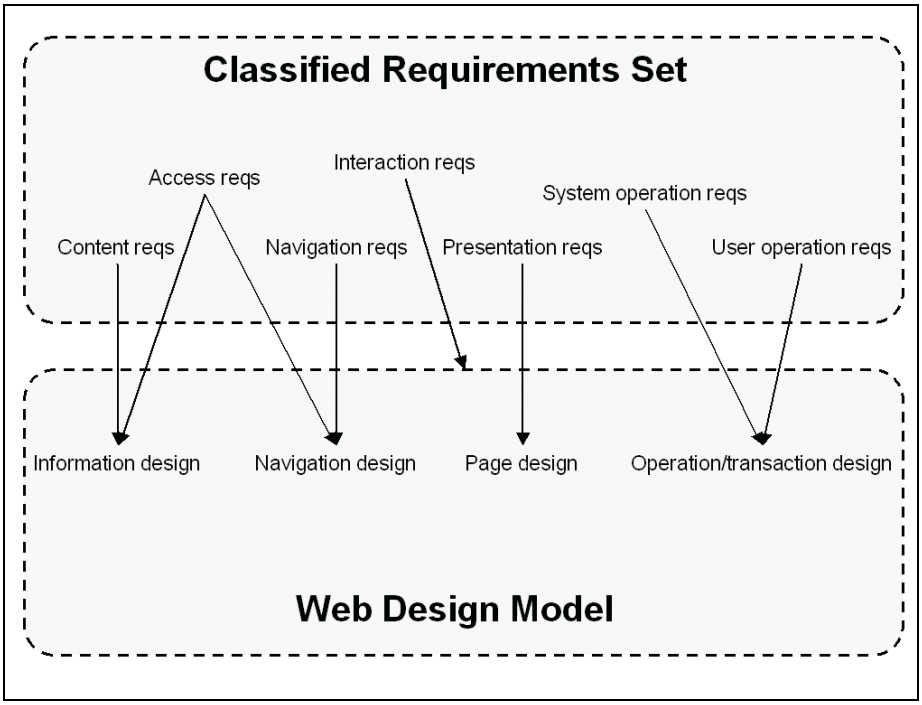


Figure 26. Correspondence between requirements and conceptual design.

AWARE requirement set does not prescribe the adoption of a specific design method. Informal and unstructured approaches – common by practitioners – may also be used to elaborate designs on the basis of the classified set of requirements.

Today, most of the structured approaches to conceptual web design share a common separation of concerns between the design of the information architecture, the design of nodes and links, and the design of the page presentation. In this context, as shown in

Figure 26, adopting a design method that provides a proper separation of concerns between the various aspects of the design may facilitate the transition between the requirement set as prepared by AWARE and the design activity.

In fact, hypermedia design models should offer conceptual constructs to define:

a) the information model of the web site. Given the content and structure requirements, this model enables to design the overall information architecture and the detailed the structure of the types of information objects;

b) the navigation model: given the navigation requirements and the information model, this model enables to design the structure of node types and links and the detailed navigation patterns;

c) the publishing model: given the presentation and interaction requirements, and the navigation model, this model enables to design the structure of the page types (in term of layout sections and labelling);

d) the operation model: given the user operations and system operation requirements, designers may employ standard languages to precisely define the transactions and the operations that the site will support and integrate them in the overall site structure. This design aspect accounts for the transactional-style typical of traditional information system architecture. The W2000 design model provides a UML-based framework for integrating hypermedia design primitives with operations [UWA, 2001c] and transactions in a coherent fashion.

Concrete results of a successful integration of goal-driven analysis based on AWARE and hypermedia design (based on W2000) on larger projects are fully described in [UWA, 2001a] and [UWA, 2001].

3.7.5 Using Design Patterns

In order to solve given requirements in effective design solutions, designers may make use of design patterns. Design patterns are proven solutions to recurrent design problems, and they are recently receiving increasing attention from practitioners and research in HCI and web design because they are recognized to be helpful in assisting designers to bridge the gap between requirements and design.

For example, given an access requirement such as “Access products by category”, proper navigation design patterns may be selected (e.g. “index” patterns for all the

category, “guided tour” pattern for providing an introduction to the product assortment, etc.) to solve this requirement [Paolini, 1999].

Since there are design patterns concerning several aspects of the hypermedia (e.g. interface patterns, navigation patterns), and also patterns concerning the technical infrastructure of an application (traditional software patterns, architectural patterns [Gross, 2001]), the organized set of requirements may be more easily translated into design solutions by adopting proper patterns.

In the example shown in Figure 25 only user goals are considered for sake of simplicity. As the goals of the clients and other relevant stakeholders come into play in the requirements picture, the refinement process may have to cope with conflicts.

3.7.6 Identification of Conflicts

Let us consider a situation in which a person `Tourist` in an unspecified role has the ill-defined goal of `Seeing of the museum has something interesting to offer`. Let also consider the goals of one sponsor of the events of the museum, and the museum itself [Bolchini, 2003].

The goal analysis in Figure 27 points out that the requirements *Highlight unknown Munch’s works* clearly *conflicts* with *Highlight Munch’s famous works*, needed to support the user to get an idea of the collection and decide if the museum is worth visiting.

The identification of the conflict (represented by a crossed line) helped designers to reflect on possible design strategies accommodating both requirements, thus fulfilling the stakeholder objectives *and* supporting the need of the users.

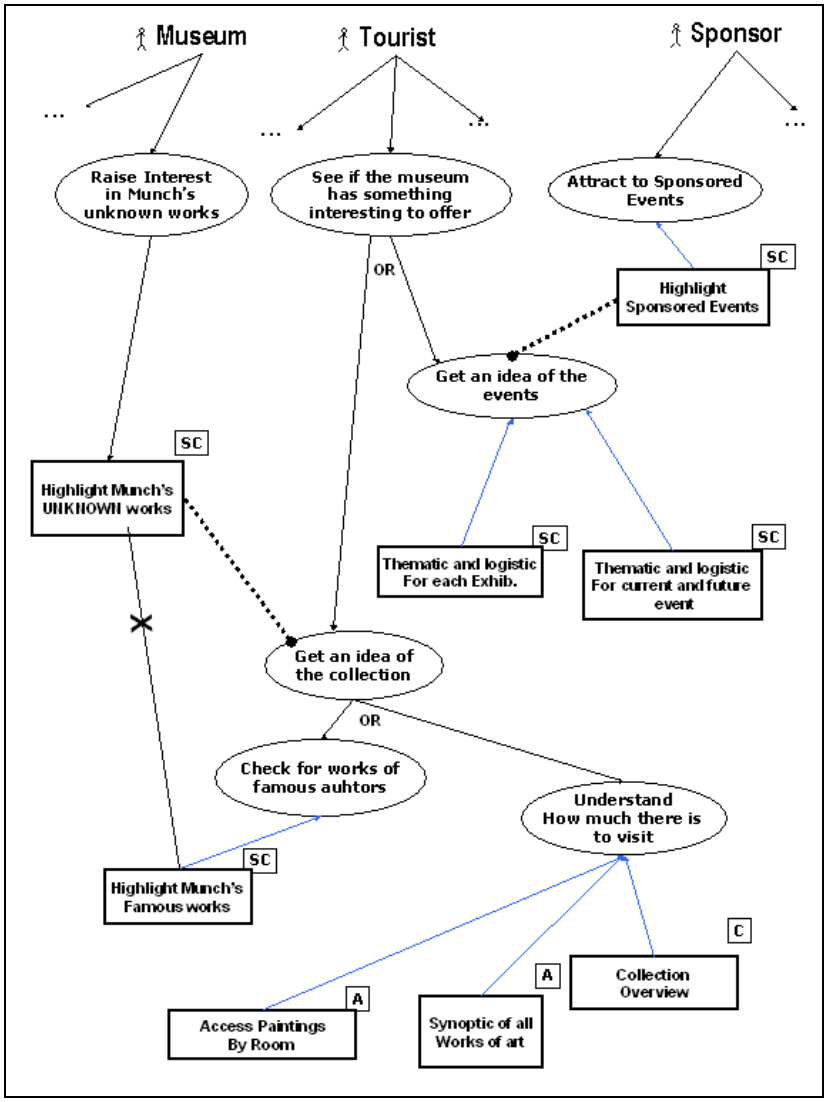


Figure 27. Emerging Conflicts and Influences in Goal Analysis[12].

In fact, the requirement *Highlight Munch's unknown work* will have an effect (represented by a dashed line) on the user goal *Get an idea of the collection*. What this effect will be, it partly depends on how designers will solve that requirement. On one hand, the requirement *Highlight Munch's unknown work* might be an obstacle to the initial goal of the user, who expected to have the chance to see famous works. On the other hand, depending on how the unknown works will be introduced and presented (for

[12] Conflicts and influences are just some examples of goal relationships that may be useful in analyzing goals. All goal relationships provided by the *i** framework [Yu, 1993] may be also used in AWARE goal graphs.

example explaining their richness and artistic uniqueness), the user might become intrigued and interested in exploring them. Usability evaluation may then help to evaluate the effect of the design decisions.

Another important requirement issue arises where the tourist goal *Get an idea of the events* meets the sponsor goal *Attract to sponsored events*. A requirement descending from the latter is *Highlight Sponsored Events*. This requirement has an impact on the tourist choice of seeing interesting events and selecting the events to attend. Depending on how designers will solve this requirement, the user goal *Get an idea of the events* might be more or less affected by the sponsor's will to push events promoted by its brand.

3.7.7 Making Use of Priorities in Goal Graphs

How conflicts may be addressed during requirements analysis? Negotiation and communication play a major role in resolving conflicting viewpoints in the requirements analysis. In this context, priorities may be a tool to support negotiation in conflict resolution. In fact, we have seen that it is possible to assign different types of priorities to goals and stakeholders (see 3.5.6).

Acknowledging the opportunity of labelling goal graphs with attributes expressing the preferences of the stakeholders [Kaiya, 2002], AWARE priorities are introduced in the goal refinement representation.

Priorities may help in solving conflicts because they may point out the relative importance and weight of the elements of the analysis, enabling analysts to make informed decisions in conflicting situations.

However, it may be not enough to assign priorities to stakeholders, goals, and to the relationship between a goal and stakeholders. Since requirements are the final result of the goal analysis, and the actual material to be fed into design, it would be necessary to have a priority on each requirement identified during the analysis, in accordance with the priorities assigned to high-level goals and stakeholders.

To this end, AWARE suggests a simple principle for propagating priorities in goal graphs. The basic idea is enable analysts to calculate the priority of a requirement on the basis of the priority values assigned to goals and stakeholders.

Let us consider the same refinement example already shown in Figure 27, but having assigned a priority to each stakeholder (*Stakeholder Priority*), a priority to each relation goal-stakeholder (*Stake Priority*). The result of this priority assignment is shown in Figure 28.

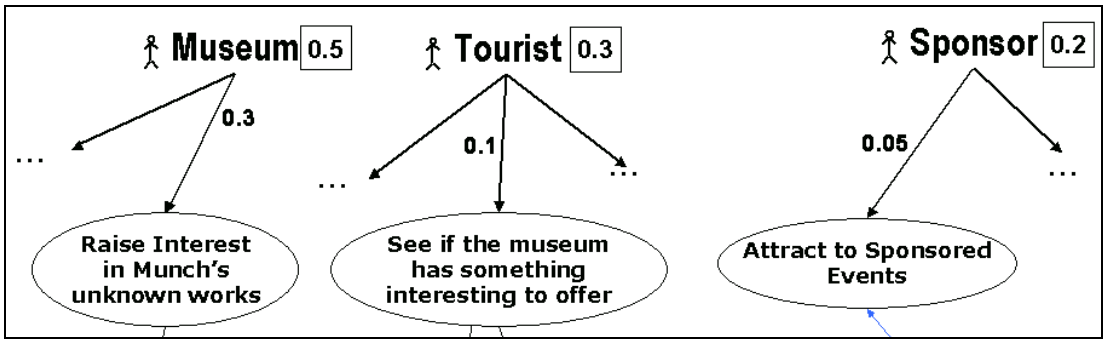


Figure 28. Assigning Stakeholder and Stake Priorities.

Each stakeholder may be given a stakeholder priority, so that the sum of the stakeholder priorities is equal to one. To each relationship stakeholder-goal may be given a stake priority, so that the sum of the stake priorities for each stakeholder is equal to one.

How can these high-level priorities may be propagated to goals, subgoals and eventually to website requirements?

When decomposing a goal into subgoal, and eventually into requirements, each decomposition arch may be assigned a priority value, meaning the degree of contribution or importance of the lower artefact (goal or requirement) to the satisfaction of the upper goal.

For each decomposition, the priorities assigned to the arches should be normalized to one. The priority of a given artefact (being it a goal, a subgoal or a requirement) may be calculated by formula:

$$P(r) = \sum_{i=1}^{n} P(a_i) P(u_i)$$

Whereas:

r is an artefact (either a goal or a requirement) of the goal graph;
i is the number of incoming arches to the artefact;
P(a$_i$) is the priority associated to the arch ***i*;**
u is the next upper artefact (either goal or a stakeholder);
P(u$_i$) is the priority associated to the next upper artefact.

Consider the application of this propagation principle to the example in Figure 29.

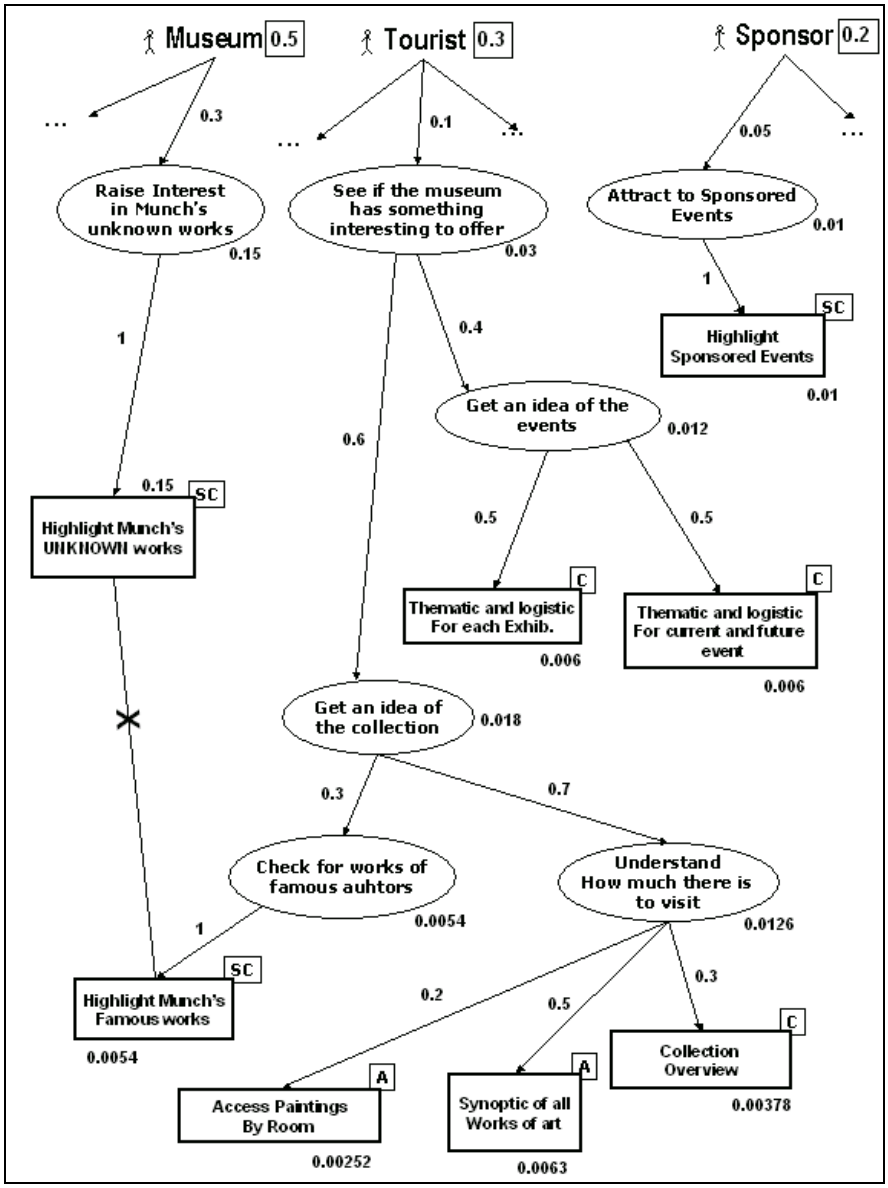


Figure 29. Propagating priorities from goals to requirements.

In the case of the conflict between the requirements `Hightlight Munch's famous works` and `Highlight Munch's unknown works`, analysts can use priorities to discriminate the importance of the requirements identified, and give proper guidance to the design activity. In this case, `Highlight Munch's unknown works` turns out to be more important than the competing requirements, and hence it will be favored in the design. In the example, the requirement `Highlight Munch's unknown works` (priority value: 0.15) has to be favored on the requirement `Hightlight Munch's famous works` (priority value: 0.0054).

3.8 The Metamodel

The AWARE metamodel shown in Figure 30 gives a complete synoptic of the constructs discussed so far.

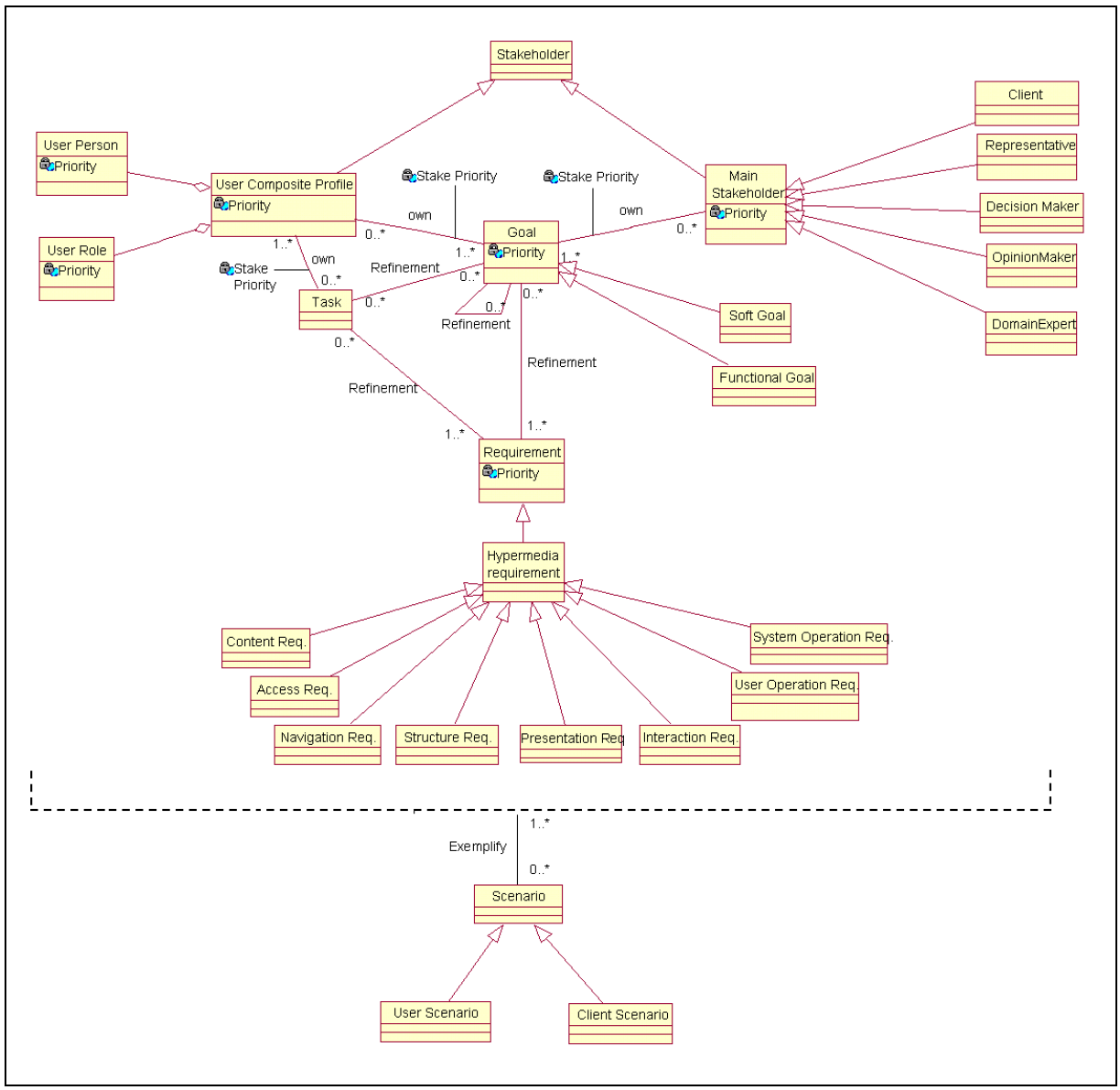


Figure 30. **AWARE metamodel expressed in UML notation.**

Stakeholders are reified by user composite profiles (composed by combining user persons and roles) and by clients and main stakeholders. Main stakeholders may be clients, representatives, decision makers, opinion makers, or domain experts.

Both families of stakeholders own goals with respect to the website-to-be. Users may also own tasks to be performed on the site. Priorities values may be associated to goals, tasks, and to their relationships with the relative stakeholders, who may have their own priorities.

To obtain operative guidelines for the design, goals – either functional or non-functional (softgoals) – may be decomposed into subgoals, tasks, and eventually refined into requirements. Requirements priorities may also be derived by prior priority assignments. Hypermedia requirements are classified according to a hypermedia taxonomy to organize the requirements set and facilitate the transition towards web conceptual design.

Scenarios are pervasive in all the analysis process and are conceptually connected to any of the AWARE constructs because they may help exemplify and instantiate any of the elements.

The metamodel highlights more vividly that AWARE owes some of its basic constructs to the *i** framework. AWARE borrows the concepts of high-level goals and stakeholders typical of *i** and extends the analysis process towards the definition of hypermedia-specific requirements for the website.

3.9 A Process Guide

AWARE does not prescribe a rigid method to be followed because requirements analysis is a complex task where a lot more variables come into play than the ones that a methodology can envision. Therefore, analysts and designers can select the AWARE constructs most suitable to the needs and constraints of their project and use them as they find useful.

However, an ideal process guide (see Figure 31) that abstracts from the details, unforeseen circumstances and idiosyncratic features of the single web project, may provide the big picture of the key activities where all AWARE elements may be used coherently.

The requirements analysis process shown - highly iterative and incremental – abstracts also from other intertwined activities such as requirements elicitation and design prototyping, in order to isolate the essential activities covered by AWARE. According to this process guide, a graphical notation for the AWARE primitives supporting the analysis process is provided in ANNEX I.

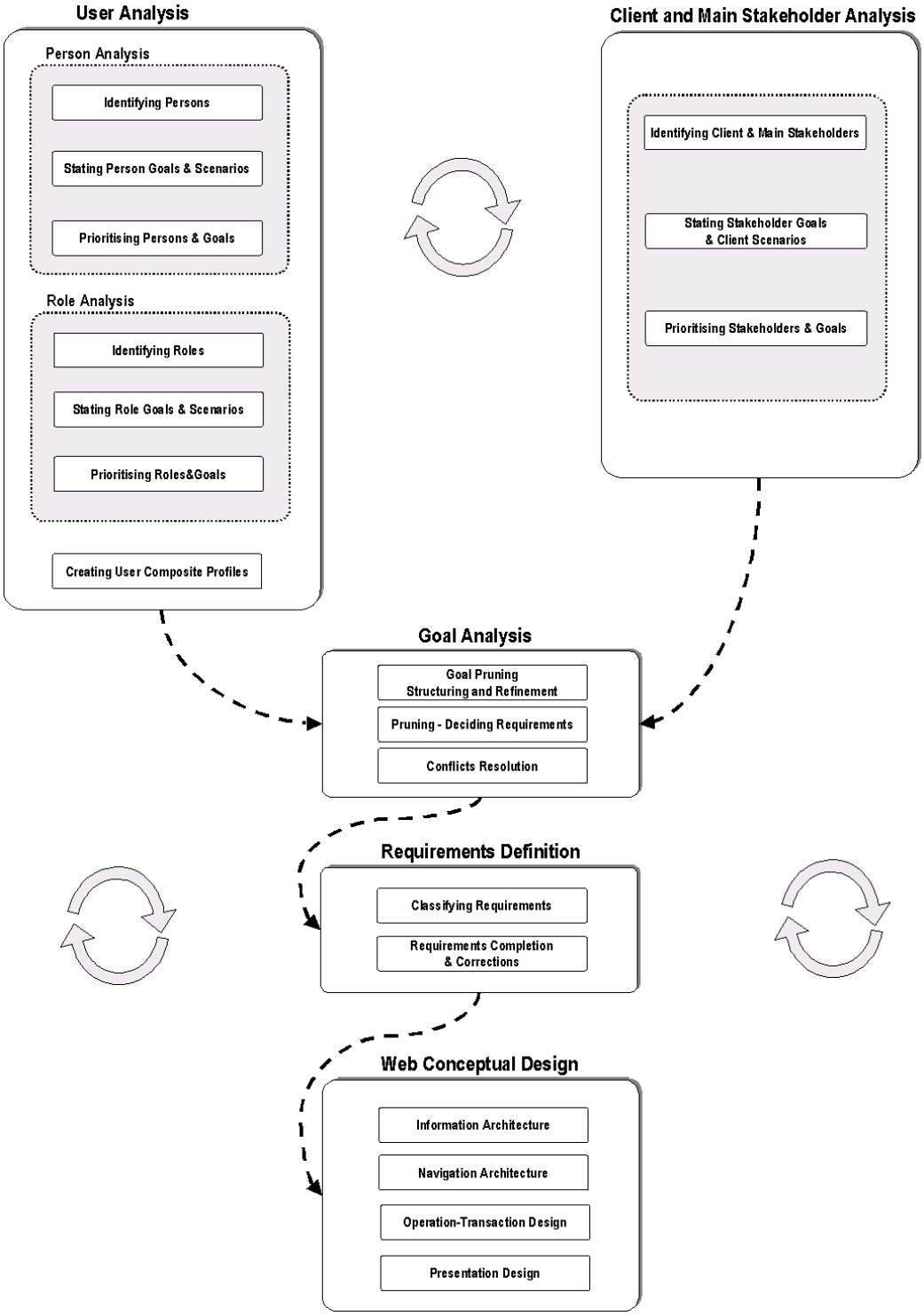


Figure 31. The iterative process of AWARE requirements analysis.

3.10 Reusing Requirements for Usability Evaluation

The results of the requirements analysis should provide the basis for planning the usability evaluation of the website.

Web usability evaluation aims at assessing the effectiveness of a website for its users in order to enhance the quality of the user experience.

Usability evaluation methods for the web usually blend different variants of two basic approaches: expert review (usually referred to as *inspection* [Nielsen, 1994]) and user testing. During expert review, one or more usability experts perform critical tasks on the web site to detect potential usability breakdowns. Inspection may be done at low cost after the deployment of the web site, after a prototype is available, or even early in design. In a user test, a sample of potential website users is recruited. A set of tasks is assigned to the users and their task-driven interaction with the application is monitored.

Usability inspection and user testing complement each other, whereas the former provides systematic and analytic insights in the application, and the latter may validate (or invalidate) the results of the inspection with real users.

As systematic approaches to hypermedia and web site usability suggest [Matera, 2002], planning a usability inspection means:

a. defining the areas of the application to evaluate and the *design aspects* to consider (performance, content, layout, etc.);
b. prepare the set of *tasks* that the inspector will perform to assess the aspects at issue in a systematic and analytic way;
c. define the *usability attributes* (also called *usability issues*) to be considered for each task.

Using MiLE web usability method [Bolchini, 2003c], an inspection matrix like the one showed in Table 3 may be prepared[13].

[13] The matrix showed has been developed for the B-silver project described in Annex II.

Usability Attributes
{sources: non-functional requirements, usability method}

Inspection Tasks
{sources: users scenarios}

	T1	T2	T3	T4	T5
	Look for Shipp.	Get an idea	Get an idea of	Look for a	Check added-v.
	Details	of assortment	product prices	specific product	services
CONTENT					
Accuracy					
Authority					
Completeness					
Currency					
PRESENTATION					
Clearness					
Consistency					
Perceived Order					
NAVIGATION					
Effectiveness					
Orientation					
Status Visibility					
Predictability					
ACCESS					
Accessibility					
Organization					
Learnability					

Table 3. Usability Inspection Matrix

AWARE provides hints to plan the usability inspection because the usability experts can easily draw large part of the material needed for the evaluation right in the AWARE requirements specification:

a) The *tasks* (columns of the matrix) that the inspector will perform could be easily taken out from the user goal and scenario analysis. The inspector can also elaborate further on the tasks and goals, detail them, or find exception cases.
b) *Usability attributes* (rows of the matrix) tend to correspond to the non-functional requirements. Inspectors may select appropriate usability attributes that are relevant for a given task. The same usability attribute can be used for different tasks.
c) Usability attributes are organized through the requirement taxonomy. In this way, the inspection can focus on relevant *design aspects*. In fact, some usability attributes measure content aspects, other are more suitable for measuring navigation aspects, other assess presentation features and so on.

How may the usability matrix be used?

To perform the inspection, usability experts systematically try to accomplish each single task on the website. They evaluate not only whether each task is feasible but also assess each task by means of the usability attributes.

For example, while trying to perform the task *Get an idea of the assortment* the inspector wonders: *How is the product family information accurate? How is the presentation consistent among pages traversed? How is the navigation architecture of the visited section self-evident? How are the link labels predictable?* And so on and so forth for each task.

On the basis of his evaluation experience, and putting himself in the shoes of a potential user by means of *visioning* techniques [Cato, 2001], the inspector fills in the matrix by assigning a value (qualitative or quantitative) to each task for each relevant usability attribute considered. Note that not every usability attribute may be relevant for each task.

This first analytic evaluation could then serve to usability experts as input for future elaboration. For example, goals, task, stakeholder and requirements priorities may be reused to weigh the values of the usability inspection according to the importance assigned to the tasks, and to the relevance of a usability attributes for a user profile[14]. The user testing is then organized on the basis of the results of the inspection, once critical tasks have been identified.

As such, usability evaluation is not an independent activity abstracted from the aims of the application, but it is strongly founded on the user goals and on the quality attributed envisioned at requirement time.

[14] Advanced requirements-driven aspects of usability inspection have been defined in the MiLE method [Bolchini, 2003c].

3.11 Summary

We have presented AWARE, a model for the Analysis of Web Applications Requirements. AWARE introduces a set of constructs for carrying out a goal-driven requirements analysis for hypermedia-rich web application, and paving the way for a stakeholder-centered web design.

The novelty introduced by AWARE can be summarized as follows. AWARE provides analysts with techniques for modelling user profiles, their goals and expectations with respect to the website, as well as clients and main stakeholders' objectives. The traditional goal refinement process is extended by introducing high-level communication goals in the requirements picture, emphasizing the priorities of the different stakeholders involved, and introducing a hypermedia requirements taxonomy to organize the requirements set and facilitate the design activity.

4 Validation

The validation of AWARE has two main objectives. Firstly, we want to assess how the approach is perceived and used in the industrial setting. It is important to gather insights and feedback from the experience of web practitioners using AWARE because they represent the main target audience of AWARE. To this end, besides exporting AWARE to industries through training and educational actions, an empirical survey on a small and selected sample of web analysts and designers all over Europe has been carried out during the UWA project [UWA, 2002a]. The response of the analysts provided precious input for the refinement and tuning of the model. The method and the results of this evaluation are summarized in this chapter.

A second objective of the evaluation is to assess the effectiveness of the model on an increasing number of web application projects. Two success stories of web applications developed using AWARE are the pilot applications of the UWA project, namely the credit card catalogue of Banca121 [UWA, 2001a], and Punto Comercial e-marketplace [UWA, 2001]. Moreover, AWARE has been applied to the requirements analysis of web projects from the educational, research and industrial arena, to assess the features of the model in action. Key excerpts of the requirements analysis brought forth in some project experiences are presented in ANNEX II.

4.1 Evaluation Method

Within the context of the EU-funded UWA Project (IST-2000-2513) a first empirical validation of the fundamental principles of AWARE has been completed.

The evaluation method for assessing the effectiveness of the methodology was defined on the basis of the Diffusion Theory [Rogers, 1995], which examines the rate and the motivations of adoption of a technological innovation by a group of potential users. The Diffusion Theory demonstrates that a technological innovation has chances to be successful if its quality is appreciated by the community of adopters.

Such an approach is fruitful also for the evaluation of a novel conceptual tool (such as a design or requirements method), by assessing how it is perceived, and if it is appreciated and accepted by a community of users [Kaindl et al., 2002].

The Diffusion Theory defines five *perceived quality attributes* of an innovative product, which can be also considered the five characteristics of a successful innovation.

1. *Triability*: the degree by which the product can be tried on a limit basis before adoption.
2. *Observability*: the observable results deriving from the use of the new product.
3. *Relative Advantage*: the perception of how better is the innovation than the competing solutions currently adopted.
4. *Complexity*: the innovative product should not be overly complex to understand and to use.
5. *Compatibility*: how the innovation is perceived as compatible and consistent with existing practices shared among the community of users.

Besides these attributes provided by the diffusion theory, we add two aspects that we consider important for a requirements model: Completeness and Complexity Adequateness. Completeness measures the domain coverage provided by the approach; Complexity Adequateness measures whether the conceptual tools proposed are enough to cope with the complexity of the domain (web application development in this case).

The quality of the document presenting AWARE was also assessed by means of three other attributes: Consistency, Effectiveness of the examples, and Structure Clarity. On the basis of these ten attributes, a process-oriented evaluation was conducted: it focused on the quality of AWARE, and not on the products designed with the model.

Eleven requirements analysts all over Europe were recruited (selected both from the industry and the research arena by the UWA partners) to let them know in detail the AWARE model. Obviously, the number of sample users is not representative of the community of web designers and analysts. However, it gives an initial interesting feedback on how such a systematic approach to requirements is considered by web professionals.

To avoid the premature emotional involvement of a workshop *in presentia* and consequent evaluation biases, the potential users of the model were provided with a document presenting an in-depth explanation of AWARE with examples and were then asked to provide structured feedback.

On the basis of the perceived quality criteria, an online questionnaire with 11 key questions was designed (see [UWA, 2002a] for the detailed questionnaire rationale). The analysts were asked to answer by the fourth week after the assignment of the

documentation[15]. The questionnaire was divided in two parts: model evaluation and document evaluation.

The model evaluation part asks the following questions:

Question 1: According to your experience, do you think that the model provides sufficient elements to be tested on a limited basis before adoption and definitive release?
Quality Attribute: Triability.

Question 2: Do you see preliminary observable results from the application of the proposed model to the design of web applications?
Quality Attribute: Observability.

Question 3: Do you consider the adoption of the model useful for your understanding of the relevant requirements issues for web applications?
Quality Attribute: Relative Advantage.

Question 4: Do you think that the adoption of the model can help you improving the quality and the efficiency of the requirements analysis and usability of web applications?
Quality Attribute: Relative Advantage.

Question 5: Do you think that the model is overly complex to be understood and used?
Quality Attribute: Complexity.

Question 6: Do you perceive the described approach to be compatible and consistent with the existing practices, design culture, values, standards and technologies shared in your organization/institution?
Quality Attribute: Compatibility.

Question 7: Is the method described comprehensive of the different aspects concerning practical requirements issues for web application?
Quality Attribute: Completeness.

Question 8: Are the concepts explained adequate to the complexity of the topic?

[15] The empirical evaluation was carried out in a two month period (January – February 2002).

Quality Attribute: Complexity Adequateness.

The document evaluation part asks the following questions:

Question 9: Do you find the terminology used in the document clear and consistent with your past experiences in the field?
Quality Attribute: Consistency.

Question 10: Do you find the presented examples useful for your insight in the issues?
Quality Attribute: Effectiveness of the examples

Question 11: Do you consider the structure and format of the document reasonably clear, effective and consistent?
Quality Attribute: Structure Clarity

For each question the evaluators could choose among the following options to express their level of agreement: Strongly Agree / Agree / Disagree / Strongly Disagree. A 'neutral' field was intentionally not defined to solicit the evaluator to express a judgment on the requested aspect.

4.2 Evaluation Results

In general, evaluators consider AWARE as a good-quality and effective proposal for modelling requirements of Hypermedia Web Applications.

The general quality mean value obtained after evaluation on every quality dimension is 1,25 on a ± 2 scale, where –2 means "strongly disagreement" and +2 means "strongly agreement". (See Figure 32)), with a standard deviation of 0,29.

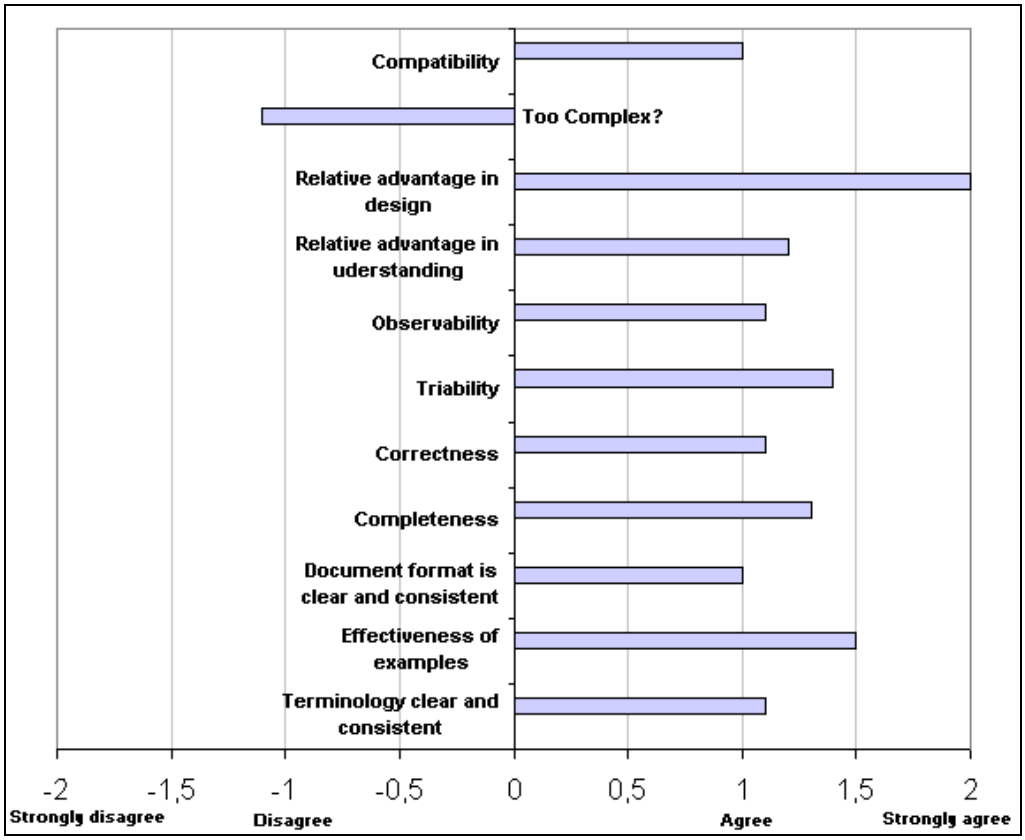


Figure 32. Synopsis of the responses of the analysts[16].

A detailed report about the techniques and results of the empirical survey is publicly available (see [UWA, 2002a]).

Besides a general positive appreciation of the approach, test analysts made also suggestions for improvements, such as:

a. detailing a process guide that might lead in the requirements analysis;
b. highlighting more clearly the link between requirements and web site customization;
c. providing heuristic principles, golden-rules and patterns supporting the model.

Whereas a process guide has been elaborated and presented in this thesis, point b) and c) need further project experience and are part of future work.

[16] The complexity value may appear a negative judgment. Reviewers disagreed when asked whether the method is too complex. Thus, the value is to be read as a positive appreciation.

5 Conclusions

The quality and effectiveness of web applications may be improved by paying particular attention to the activity of requirements analysis, where strategic decisions are taken. AWARE is a stakeholder-centered, goal-oriented requirements analysis toolset that evolved as a result of the refinements gathered while using the model in project experiences (see Annex II) and elaborating it within a requirements engineering framework.

5.1 Key contributions

AWARE may be used by analysts and designers to deliver goal-oriented web applications, that strive an healthy balance between the achievement of the communication objectives of the stakeholders and the delivery of a satisfactory user experience.

AWARE enables to model the different user profiles representing the target audience of the site, taking into account their characteristics, as well as their goals, tasks and expectations with respect to the site-to-be. Clients and main stakeholders involved in the analysis process are also properly considered, and the impact of their goals on the design and the user experience is analysed. Prioritisation techniques are introduced to weight the relative importance of the goals and of the different stakeholders involved, so to support the scalability of the analysis activity and help prune goals along the decision making process. To manage the transition between high-level user users' and main stakeholders' goals to website requirements, AWARE adopts a goal refinement techniques, typical of goal-oriented requirements engineering frameworks such as *i** and KAOS. Besides, AWARE introduces a hypermedia taxonomy to organize the requirements set concerning with the hypermedia aspects of the web application and to facilitate the transition to web conceptual design. The outcome of the AWARE requirements analysis may be effectively reused for planning a systematic usability evaluation of the web site, as pieces of designs, mock-ups, or running prototypes are available. In fact, the requirements knowledge gathered with AWARE during the requirements phase, lends itself to be integrated into existing approaches to systematic usability evaluation. In this way, the quality user experience is assessed with respect to

the goals of the users and to the goals of the main stakeholders. As such, AWARE is intended to be a tool for the negotiation, analysis, validation, and communication of the requirements, to be understood and used both by analysts and web designers, and also by clients and other stakeholders.

5.2 Benefits of AWARE

Validation of the initial results of the AWARE, although carried out on a limited basis, shows the following benefits deriving from the adoption of AWARE:

1) analysts and designers are facilitated in mastering the big picture of the requirements analysis, enhancing the communication and negotiation with the stakeholders.
2) analysts have the opportunity to reflect on the goals of the different stakeholders (and not only the users), an aspect often neglected by solely user-centric techniques; in this way, they may more easily find an healthy balance between the user experience and the business/communication objectives of the site.
3) analysts are supported in maintaining proper traceability links between the stakeholders, their high-level goals and the website requirements.

5.3 Limitations of AWARE

A number of limitations of the current version of the AWARE model have also to be noted.

1) A validation on a larger numbers of web projects have to be carried out; the projects carried out so far are relatively limited in scope and cover only few domains. An important evaluation task to be done would be measuring the benefit of using AWARE in alternative to other web requirements methodologies and assessing the respective quality of the final web applications.
2) Heuristics and rules to diminish the subjectivity of assigning dimensions to requirements, and define requirements at the proper level of abstraction should be defined.
3) AWARE features are expected to change, as new project experience is gained and the model is refined accordingly. Once the basic features are relatively stable and assessed, they may be encoded in a tool editor that may support the analysis process.

Future research will be devoted to address these and other issues, in order to deliver a better and more usable requirements analysis model.

6 Research Outlooks

AWARE is an initial proposal to cope with the complex aspects of requirements analysis for web applications. As such, the research done so far needs improvements, being just a first step in a relatively new research field. On the basis of the key achievements presented so far, current and future work is focusing on three main aspects of the AWARE model: validation, technology transfer, and enhancement.

6.1 Validation

AWARE is an evolving model. As we acquire project experience, we will enhance the model according to emerging needs. We are evaluating the effectiveness of AWARE by applying it to web projects of various size and in different domains. Future work will be devoted to analyzing how AWARE is usable and useful to web analysts and designers, gathering feedback from analysts with different level of expertise, such as novice, more experienced, and senior.

For example, an environment with high potential for the evaluation of the model is the Webatelier[17] course of the University of Lugano, where more than ten web projects a year are delivered for private and public companies in Italy and in Switzerland. The groups of designers may be monitored during their requirements and design activities while applying AWARE; results and feedback may then be gathered.

Another important dimension of the evaluation concerns the scalability of the model. We want to gain more evidence as whether AWARE scales up in context of large web applications (e.g. banking websites, cultural heritage web applications, e-commerce environments, tourism websites), both in regards to the constructs and to the notation provided by the model.

6.2 Technology Transfer

[17] www.webatelier.net

AWARE is meant to be a support for real analysts on real projects. However, the path from having a model to seeing it actually used and adopted by some practitioners is a long and hard one.

Current action comprises the exploitation, and the creation, of all the opportunities for introducing web practitioners to the model, and train them on how they could use it effectively. Considering the feedback gathered by these experience (some already carried out, some of them ongoing, and some to be done), AWARE is being refined, and under proper "packaging" for making it suitable to the needs of the potential adopters on the field.

Target industries are web agencies of middle and large dimensions, as well as consultancy, communication and technology companies involved in web application developments. Exporting AWARE to professional training courses for designers and analysts is already giving insightful feedback on the benefits and pitfalls of the approach.

General obstacles to technology transfer for requirements engineering techniques are the complexity of the method and the training time needed to make the method productive [Kaindl et al., 2002]. Considering these factors, the experiences gained by training practitioners will be monitored, so provide as much input as possible for making AWARE more usable, lightweight and helpful.

6.3 Enhancement

The model may be enhanced and improved under several respects.

Usable techniques should be defined for managing more effectively the documentation of the post-traceability [Gotel, 1994], that is the traceability between the requirements specification and subsequent artefacts in the development (e.g. hypermedia design). Connecting manually and graphically all hypermedia artefacts to the requirements may turn out to be infeasible for the large number of objects and connections involved. AWARE provides initial support for pre-traceability, as far as the stakeholders, goals, and requirements are cast in goal graph. However, even goal graphs may not scale very well. Solutions to make goal graphs more controllable as the number of objects grows will be explored.

Support for integrating customization techniques into the requirements framework should be defined. In the UWA project, customizing the application has been intended as applying customization rules to design artefacts so to generate tailored specifications for different devices (such as PDA, cell phones, smart phones, pocket-PCs and kiosks) [UWA, 2001e]. However, at the requirements level, the relationship and the reciprocal

influence between the customization requirements and the other requirements remains an open-issue to be further explored.

Guidelines, golden rules and patterns for the entire analysis process would be recommendable. Moreover, having AWARE modules specialized on given domains may provide analysts with libraries of prototypical goals, user persons and roles, main stakeholders and potential requirements to consider.

Heuristics for defining requirements at the proper conceptual level, for identifying, adding, deleting, and modifying design dimensions for requirements would be helpful.

Finally, tool support for AWARE may be improved. Within the UWA project, basic editor functionality for the AWARE primitives has been encoded in Rational Rose [UWA, 2002b]. Extending Rational Rose – a popular product for software developers - has turned out to be a good opportunity for facilitating the adoption of the model. However, adding explicit mechanisms to assist traceability, and requirements priority computation may further enhance tool support.

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Annex I

AWARE Notation

Abstract

AWARE is a stakeholder-centered requirements analysis toolset that may be used by analysts and designers to conceive goal-oriented web applications.

AWARE provides a notation for guiding and documenting the outcome of the requirements analysis process, and share it among stakeholders and the development team. This document presents the latest version of the notation. Note that it is not necessary to stick to this notation to make use of AWARE in an effective way. The graphical notation is just one kind of "syntactic sugar", that is one possible way of representing graphically the results of the requirements analysis. AWARE have been used in different projects with slightly different notations, yet keeping its basic semantic features.

The notation is organized in nested packages. Each package contains a series of graphical templates for assisting in documentating specific aspects of the requirements analysis. Note that the notation, as the overall model, does not prescribe a process to be followed during the analysis. However, it may help the analysts to carry out the activities in an organized and coherent fashion. The following notation packages are presented in this annex: *User Analysis* (Persons, Roles, Goals, and User Scenarios), *Client and Main Stakeholders Analysis* (Client and main stakeholders, Goals, and Client Scenarios), and *Joint Requirements Analysis* (Goal refinement, Hypermedia Requirements Taxonomy, Conflicts and Influences, and Requirements Set).

The presentation of each template within a package is accompanied by examples, so to give a concrete picture of the notation in use. Since graphical representations used in isolation often fail to express and disambiguate the meaning of the specification, the templates presented are intended to be accompanied by appropriate annotations, text documents, and links to other reference sources.

The organization in packages offers the opportunity of using the notation in a modular way: analysts may use only some pieces of the notation at their convenience, according to the needs and constraints of the project. The graphical definition of the notation given in this chapter is not aligned with the project examples presented in Annex II. The reason is that the full notation packages have been developed and refined after, and on the basis of, the project experiences illustrated in Annex II.

All AWARE templates and examples are available in MS PowerPoint format (upon request to the author[1]), to be easily edited and reused.

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Table of Contents

List of Figures

1 “User Analysis” Package

1.1 Persons

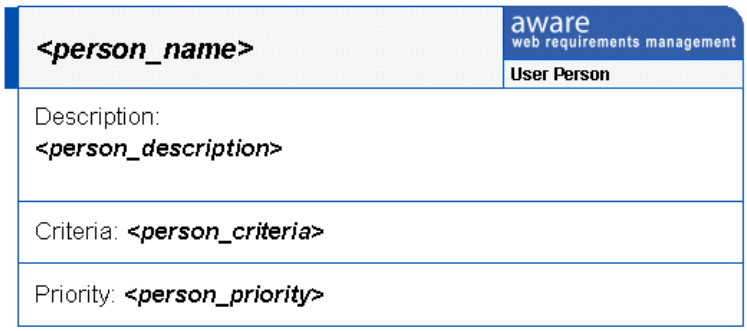


Figure 1. Person Template.

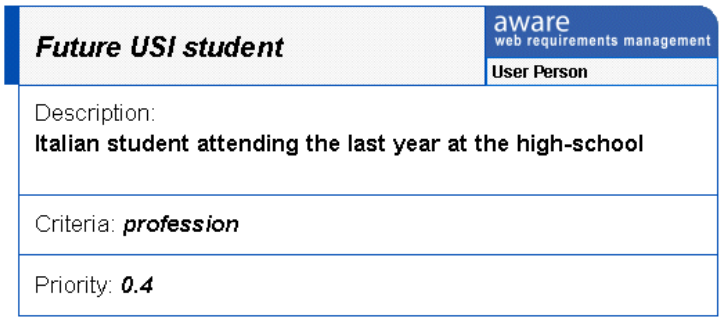


Figure 2. Example of Person.

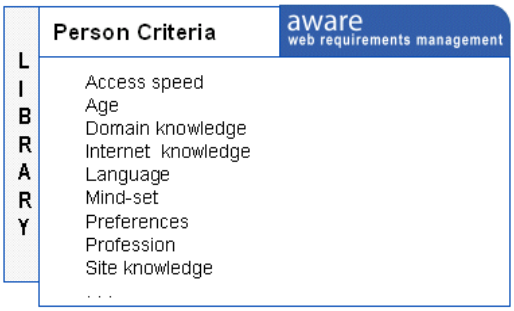


Figure 3. Suggestions for person criteria.

1.2 Roles

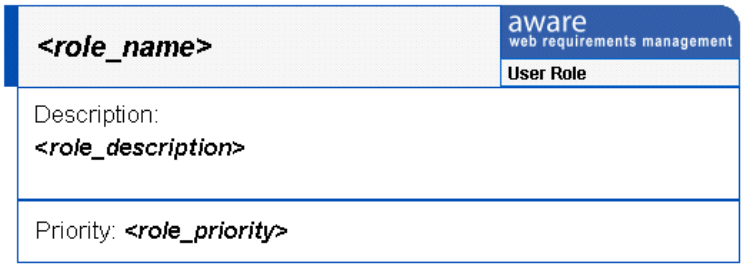


Figure 4. Role Template

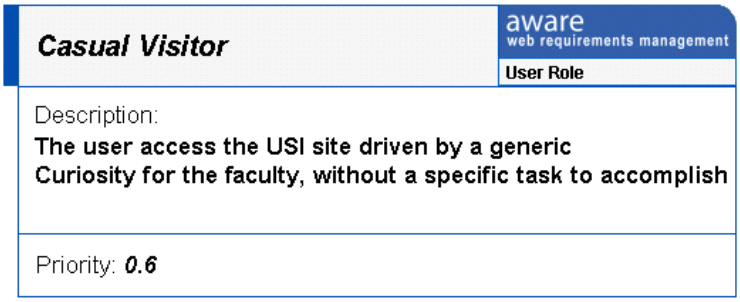


Figure 5. Example of Role.

1.3 Goals

aware
web requirements management
Person Goals

Persons	Goals	Softgoals
<person name>	▪ <goal description> ▪ <goal description> ▪ <goal description>	▪ < softgoal description {argument} >
<person name>	▪ <goal description> ▪ <goal description> ▪ <goal description>	▪ < softgoal description {argument} >
<person name>	▪ <goal description> ▪ <goal description> ▪ <goal description>	▪ < softgoal description {argument} >

Figure 6. Person Goals Template.

aware
web requirements management
Person Goals

Persons	Goals	Softgoals
Teacher	▪ Gather material for preparing a introductory lesson before the visit ▪ Organize the visit ▪ Check for given works Get useful catalogue for didactics	▪ Accuracy {art material}
Expert User	▪ quickly locate information slots ▪ keeping upbreast with the news of the site ▪ locate changes, update, and enhancement	▪ Consistency {navigation, content}
Art Critic	▪ 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	▪ Depth {art topics}
Tourist	▪ Organize a visit ▪ See if the museum is worth visiting ▪ Get an idea of the collection ▪ Check for works of famous auhtors ▪ Check parking possibilites	▪ Attractive {collection}
First-time user	▪ Being introduced to the theme of the museum ▪ Being attracted by something interesting and appealing	▪ Attractive {museum presentation, collection}

Figure 7. Example of Person Goals.

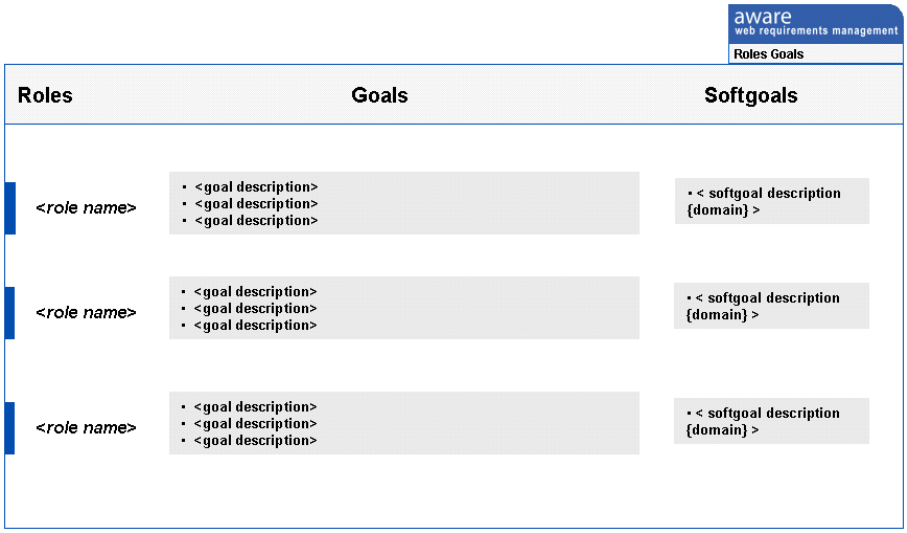


Figure 8. Role Goals.

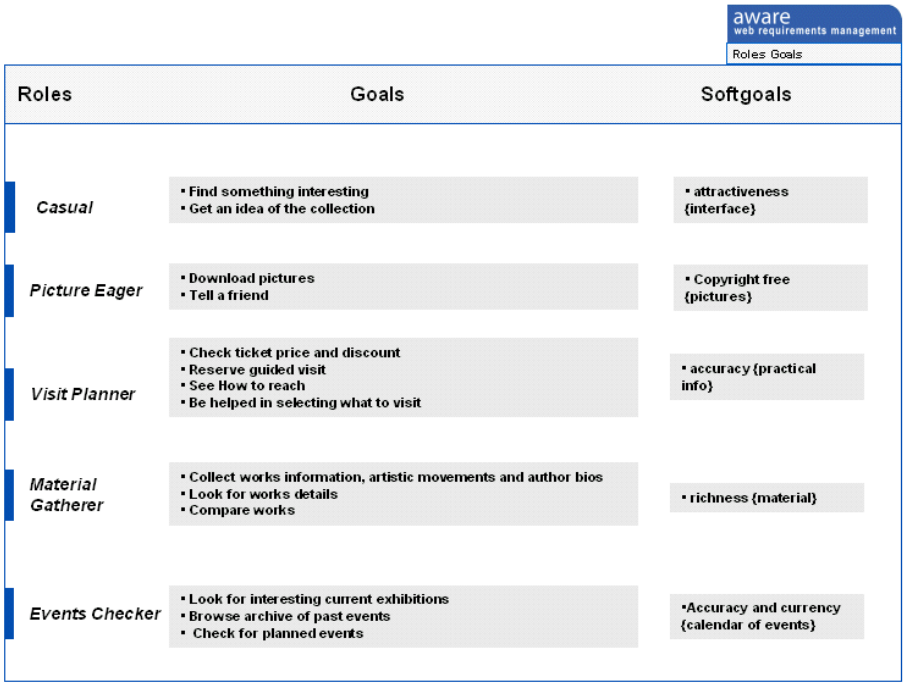


Figure 9. Example of Role Goals.

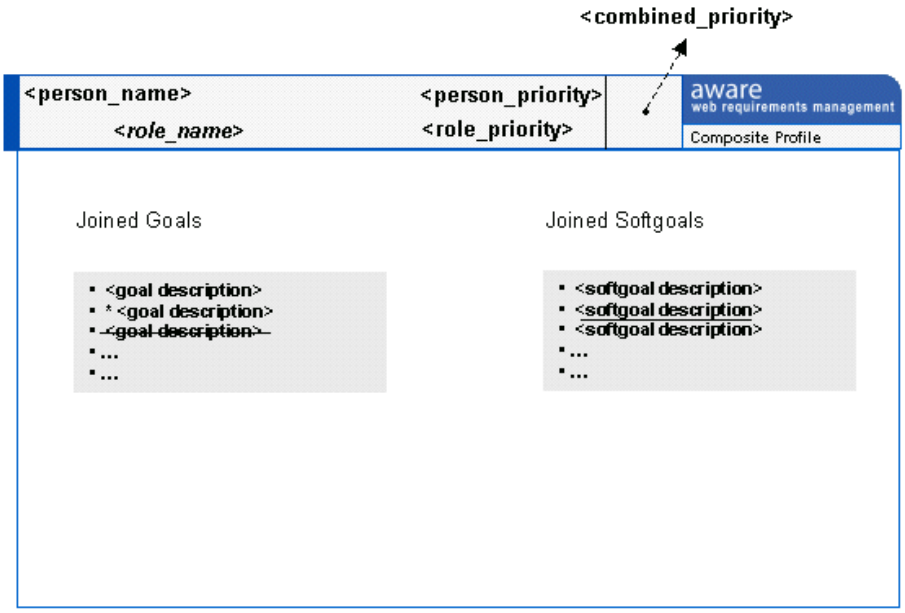


Figure 10. Composite Profile Template.

Figure 11. Notation for editing goals in composite profiles.

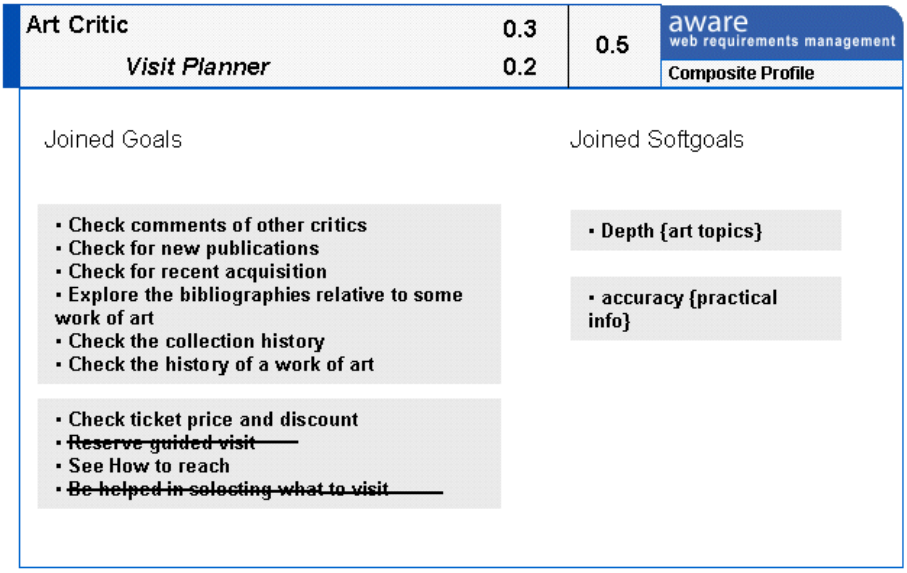


Figure 12. Example of User Composite Profile.

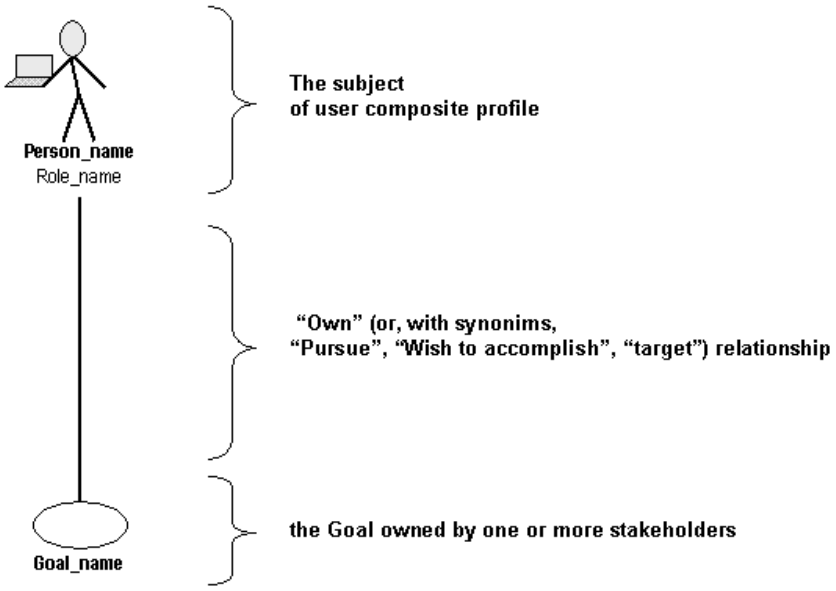


Figure 13. Template for the basic primitives of user modelling.

Goal names may be written either inside the circle, or right under it. The graph-based representation of the goals may be used in alternative or as a complement of a simple list of goals.

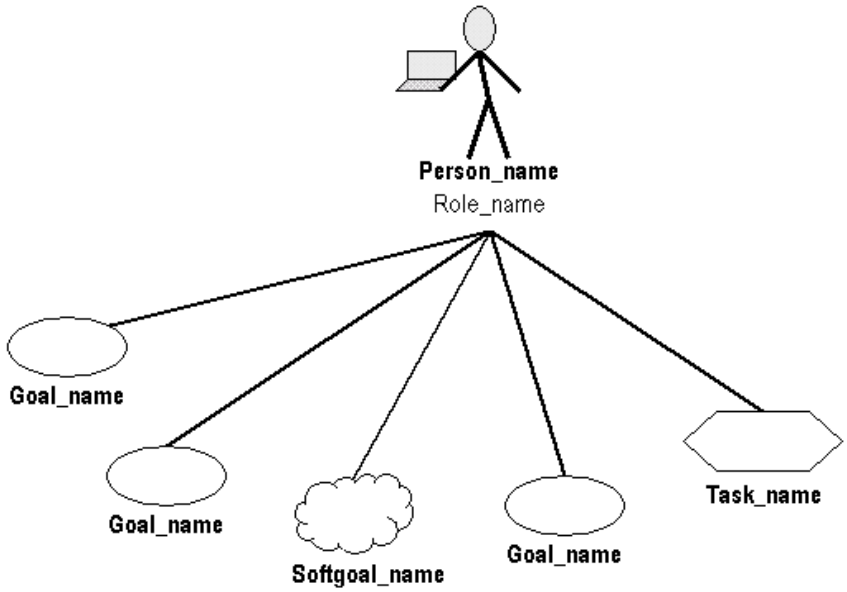


Figure 14. Graph representation of composite profiles goals.

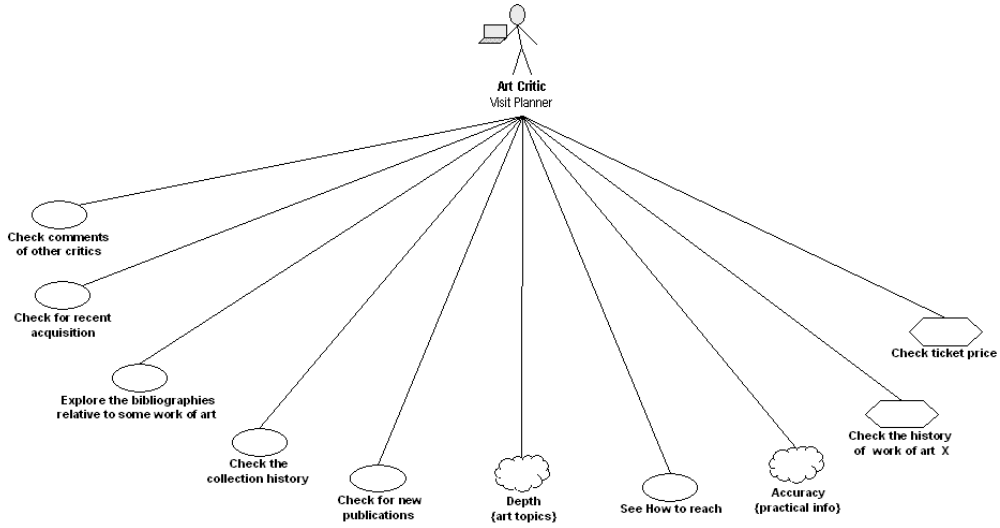


Figure 15. Example of composite profile goal graph for highest level goals.

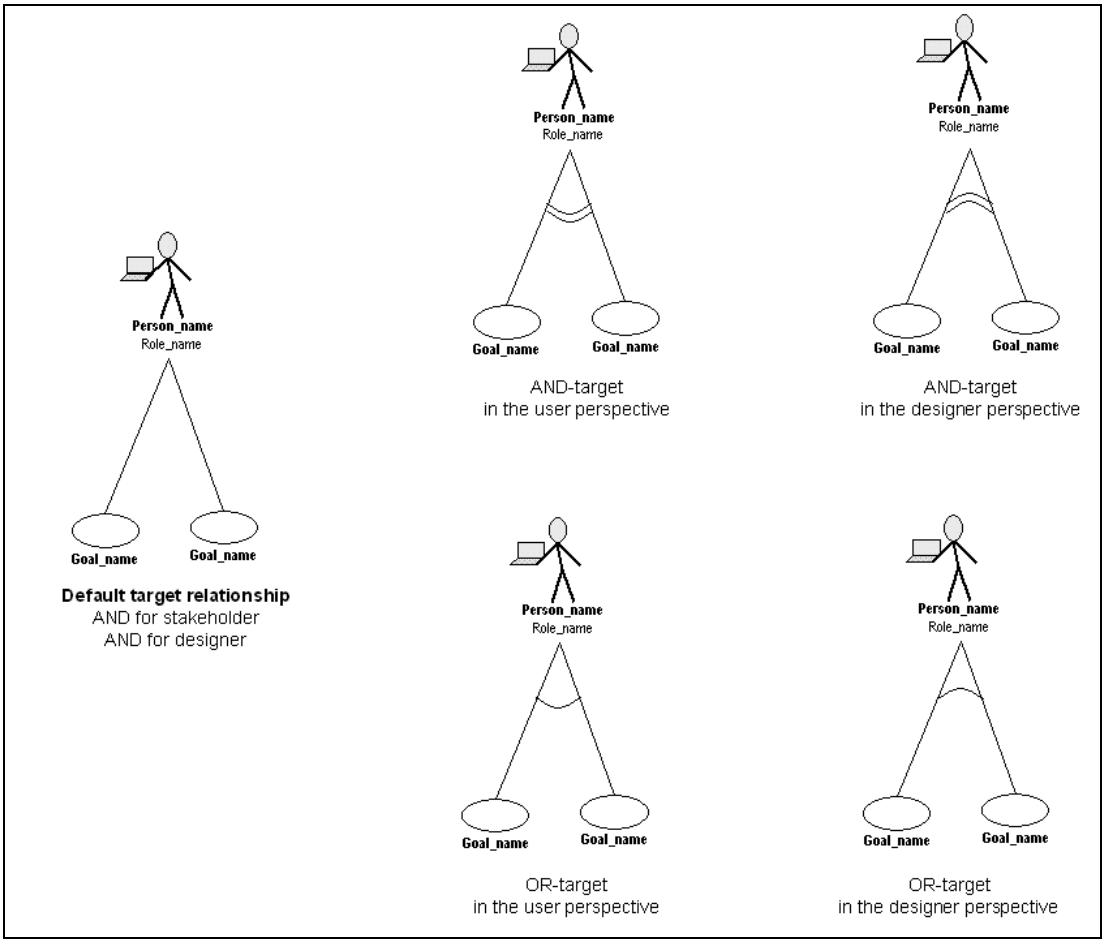


Figure 16. AND and OR relationships between user composite profile and goals.

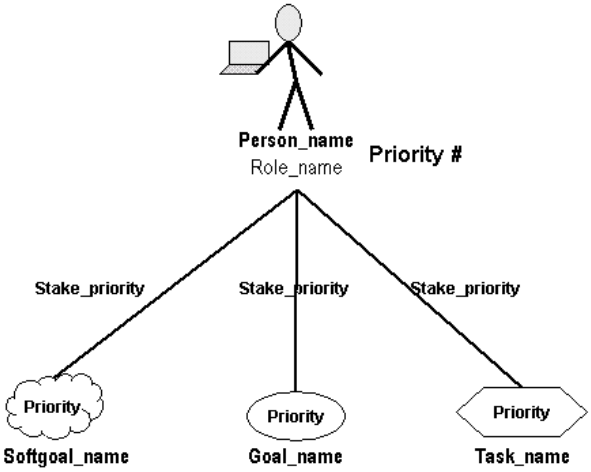


Figure 17. Profile, stake and goal priority template.

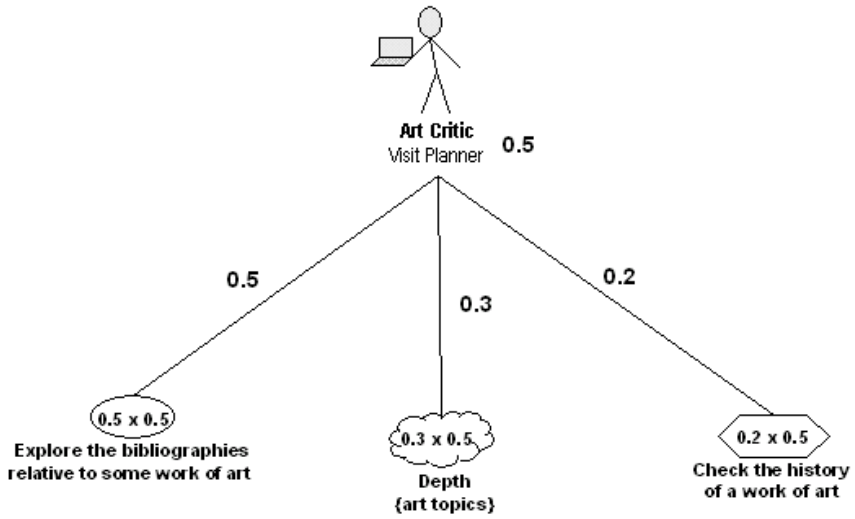


Figure 18. Example of user composite profile priorities, stake priorities, and goal priorities.

1.4 User Scenarios

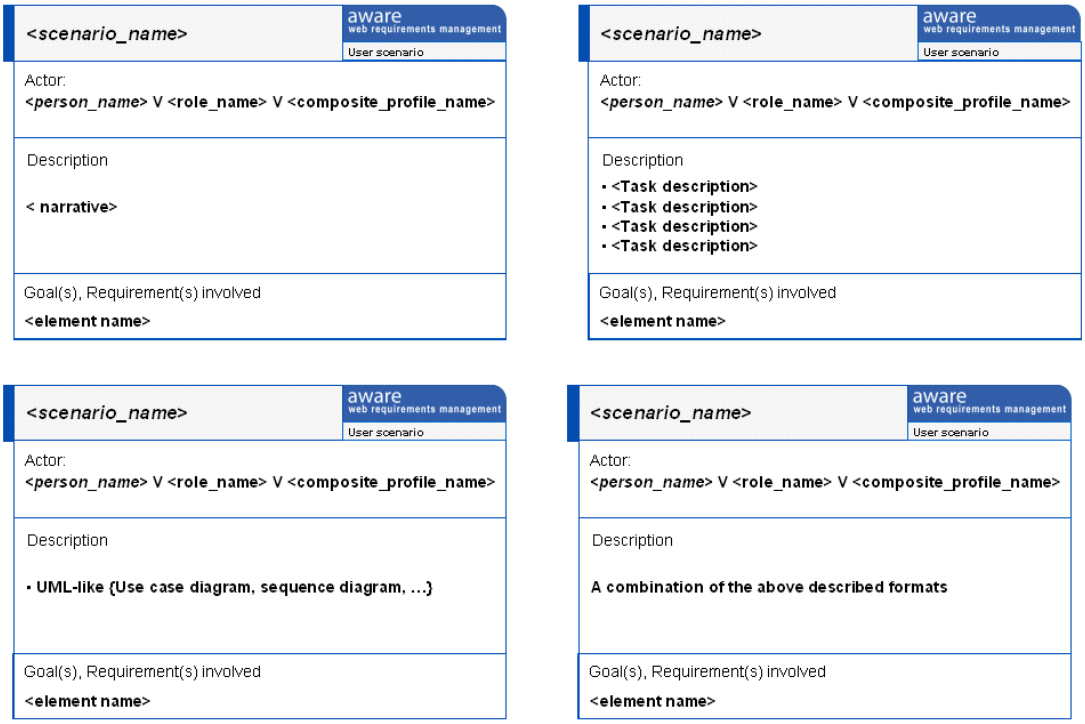


Figure 19. Templates for user scenarios.

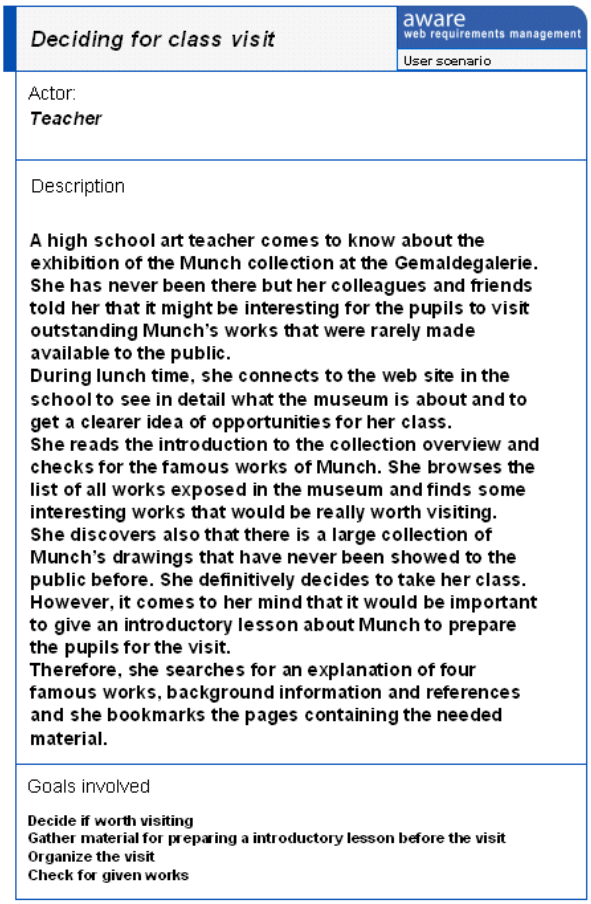


Figure 20. Example of a User Scenario in narrative form.

2 “Client and Main Stakeholder Analysis” Package

2.1 Clients and Main Stakeholders

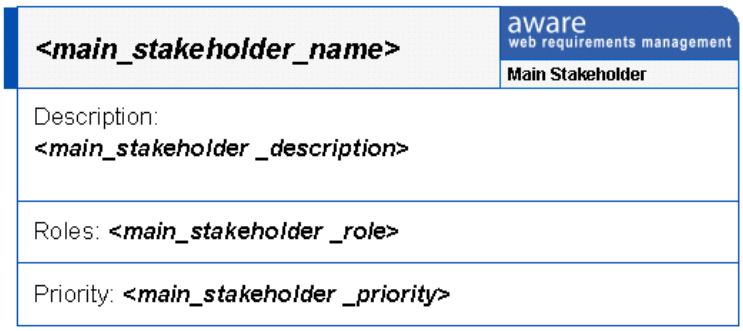


Figure 21. Template for the description of clients and main stakeholders.

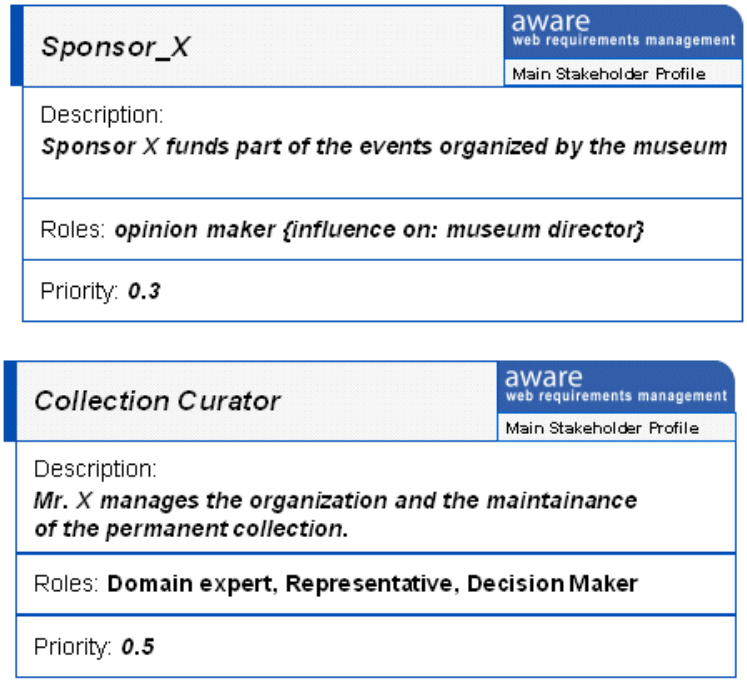


Figure 22. Examples of stakeholders.

2.2 Goals

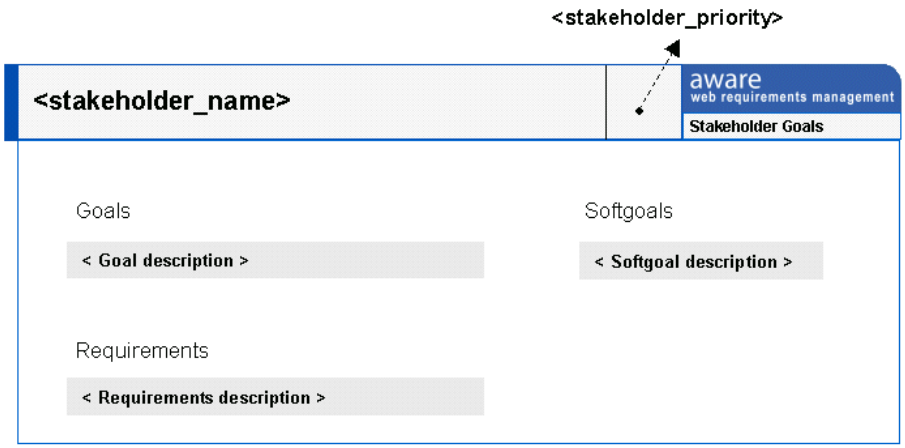


Figure 23. Template for stakeholder goals.

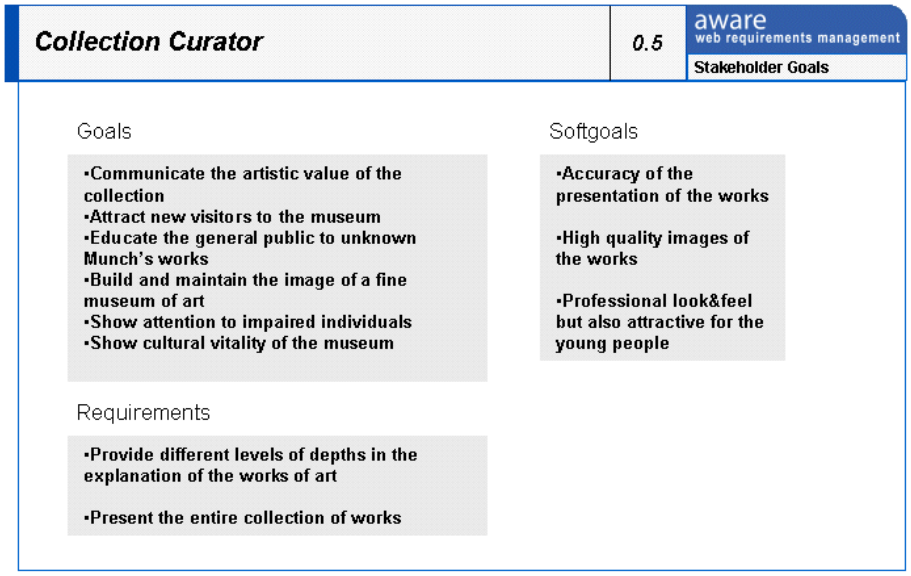


Figure 24. Example of stakeholder goals.

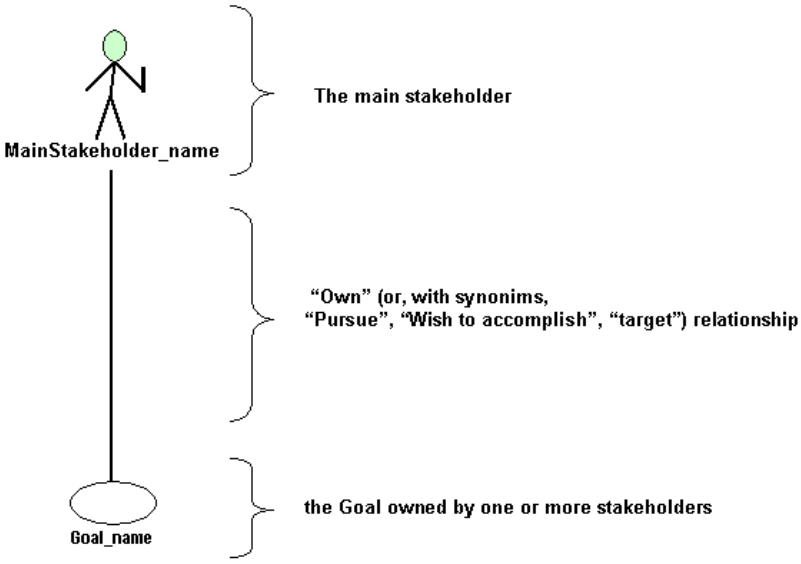


Figure 25. Template for the basic primitives of client and main stakeholders.

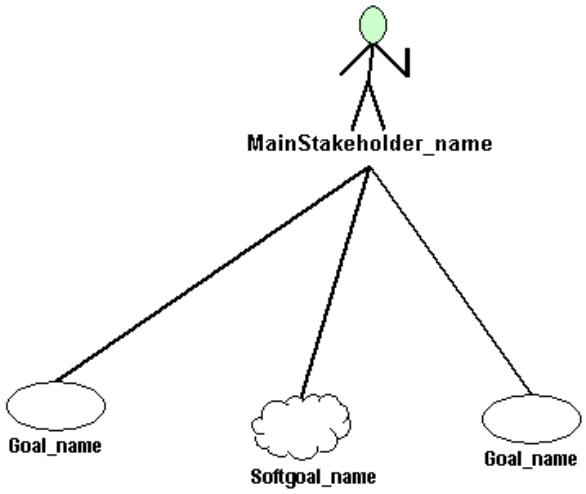


Figure 26. Template for the graph representation of client and main stakeholder goals.

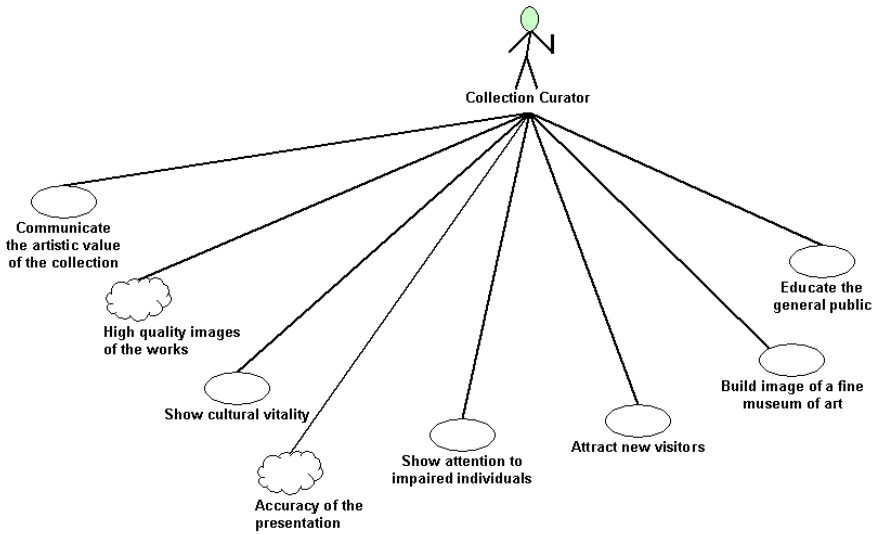


Figure 27. Example of main stakeholder goals in a goal graph.

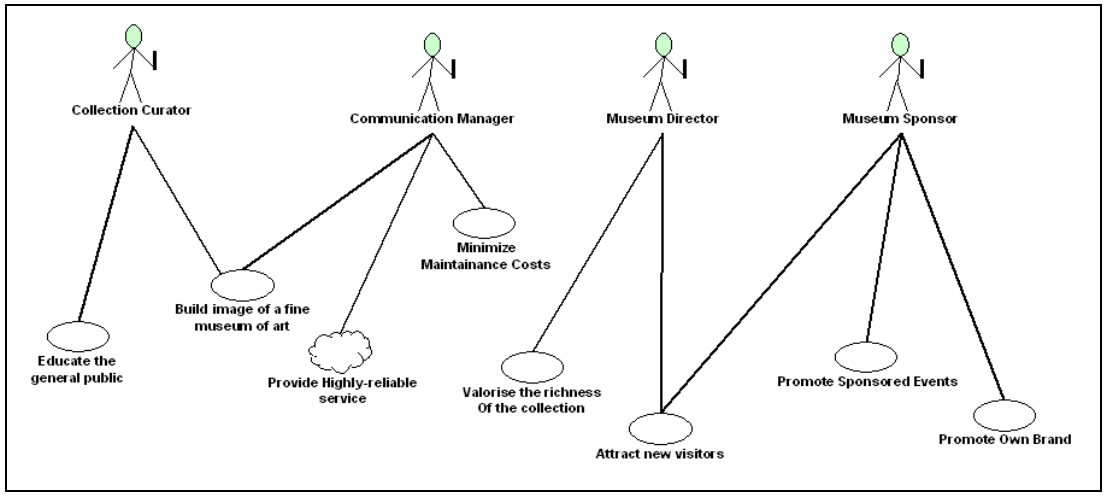


Figure 28. Examples of main stakeholder first-level goals without priorities.

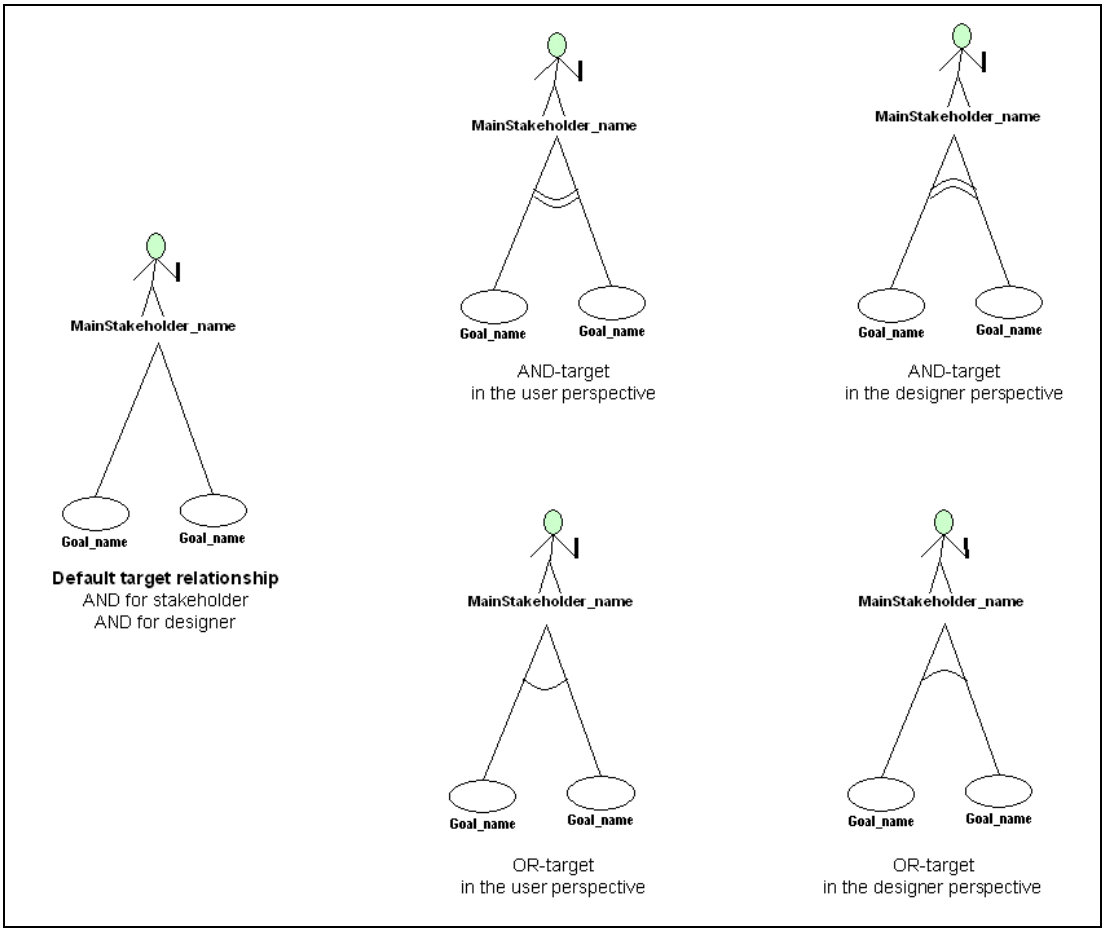


Figure 29. AND and OR relationships between main stakeholders and goals.

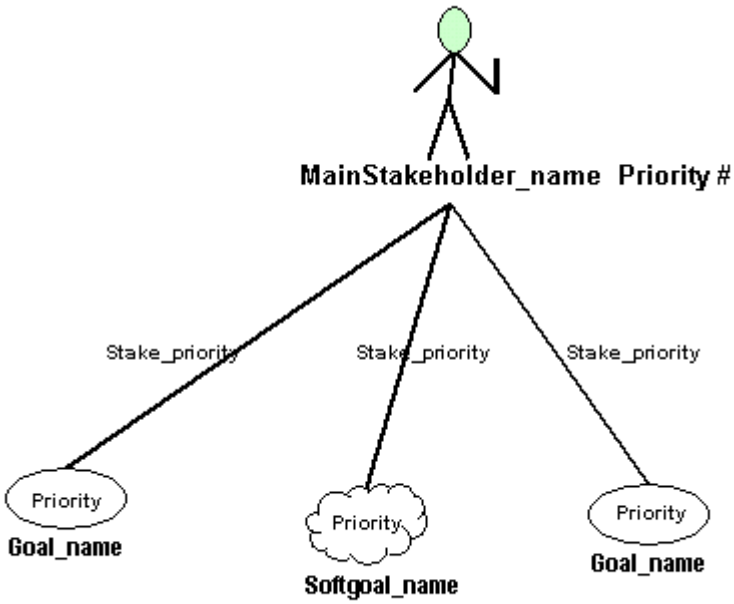


Figure 30. Template for main stakeholder goals with priorities.

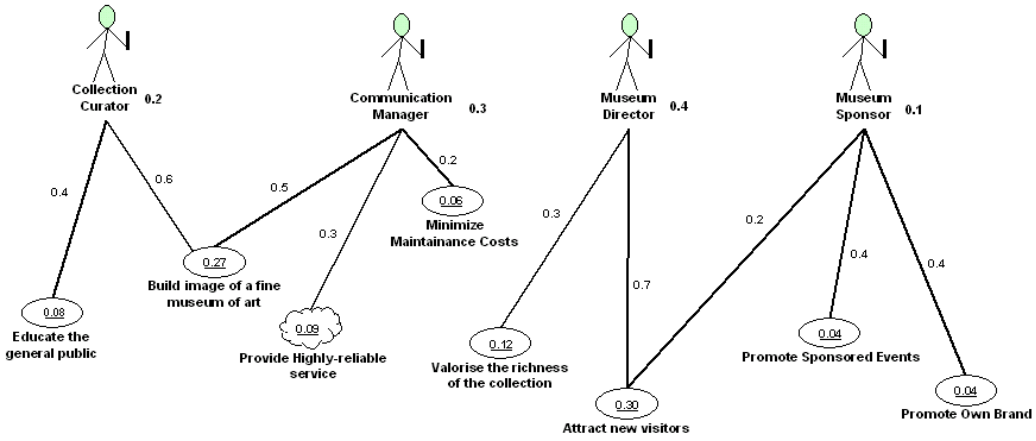


Figure 31. Stakeholder and stake priorities are assigned. First-level goal priorities are calculated accordingly.

2.3 Client Scenario

Figure 32. Alternative templates for client scenarios.

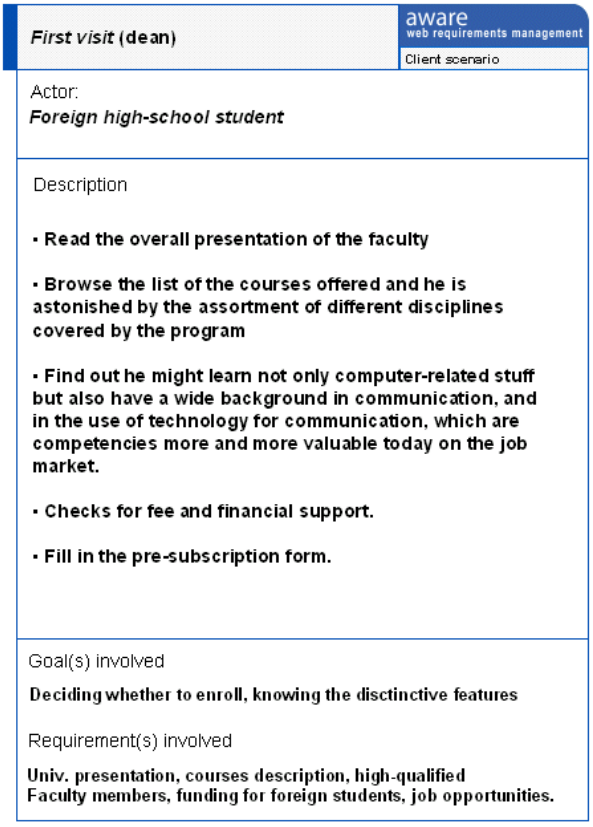


Figure 33. Example of client scenario.

3 “Joint Requirements Analysis” Package

This package is intended to be used to analyze user and main stakeholder goals and refined them into website requirements.

3.1 Goal Refinement

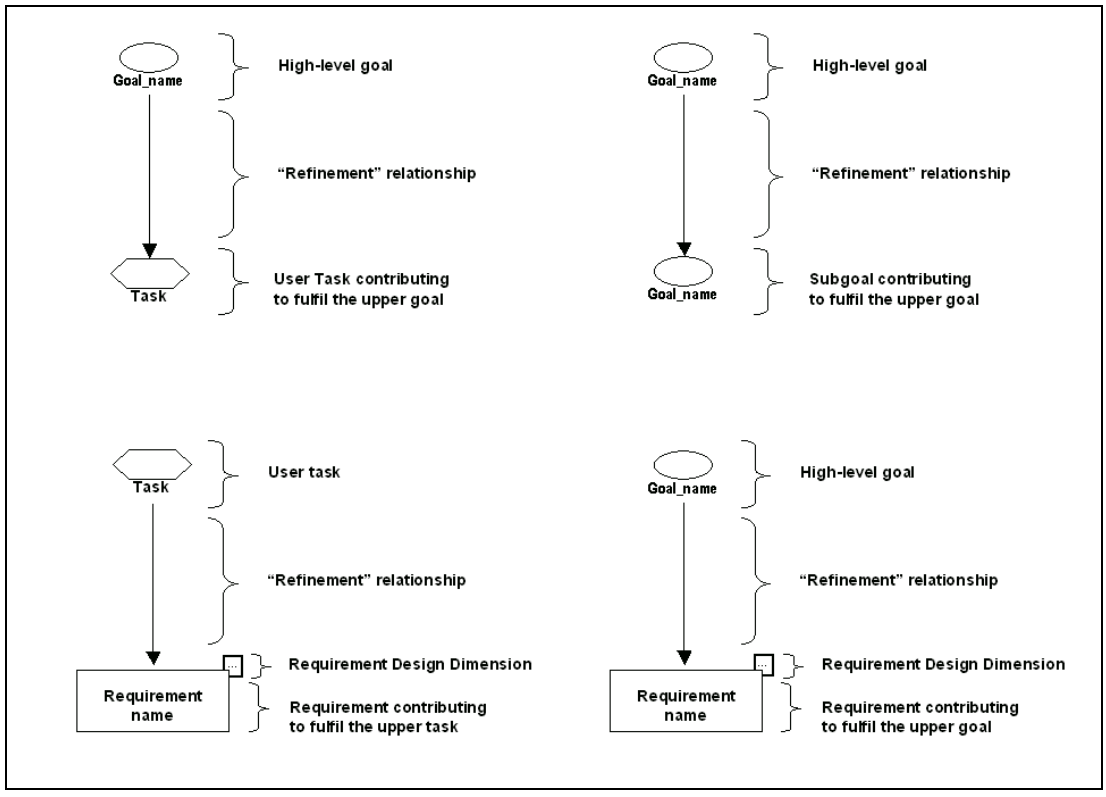


Figure 34. Templates for the primitives of goal refinement.

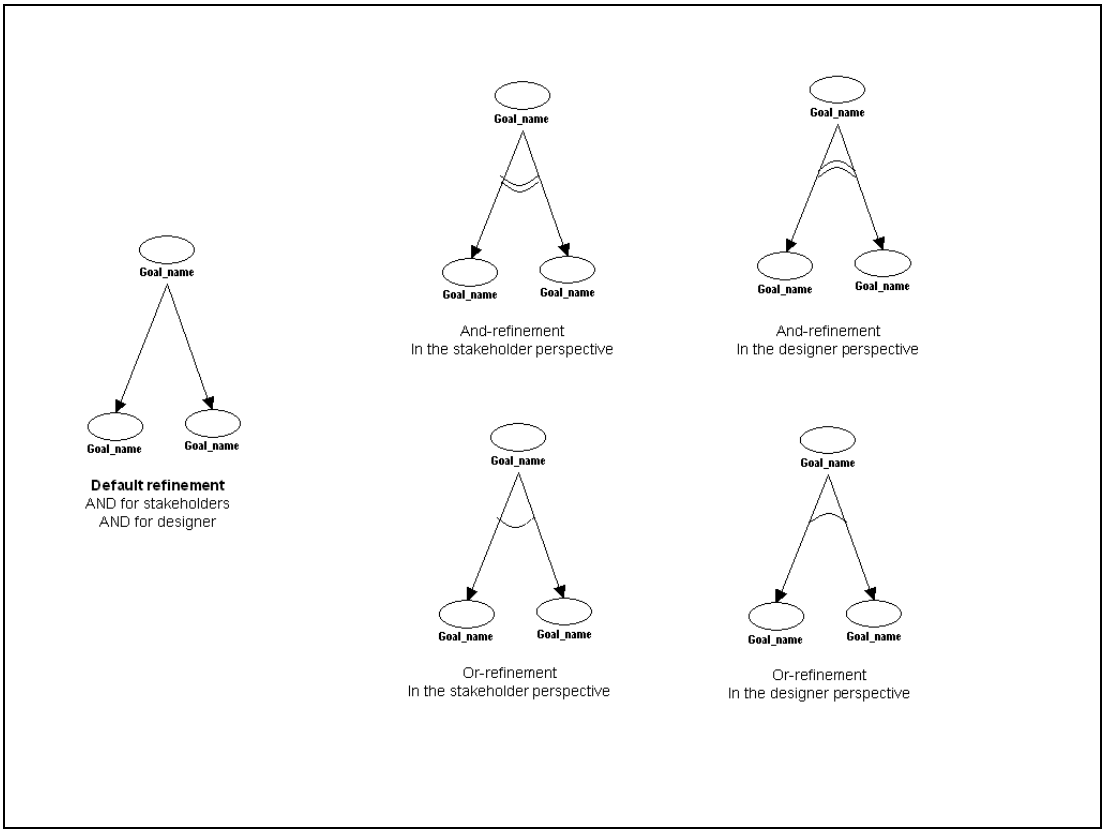


Figure 35. Templates for AND and OR relationship in goal refinement.

3.2 Hypermedia Requirements Taxonomy

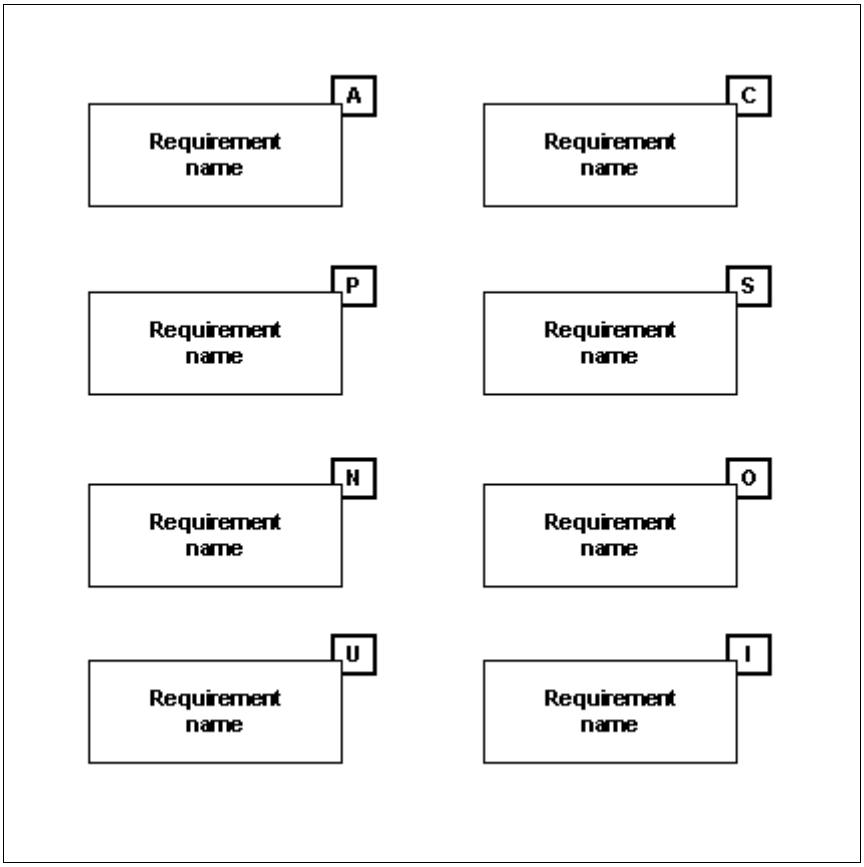


Figure 36. Notation for the requirements taxonomy.

A: Access
C: Content
P: Presentation
S: Structure of Content
N: Navigation
O: System Operation
U: User Operation
I: Interaction

Besides the hypermedia taxonomy, other requirements may, for example, concern *management* (**M**) and *performance* (**F**).

3.3 Conflicts, Influences and Priority Propagation

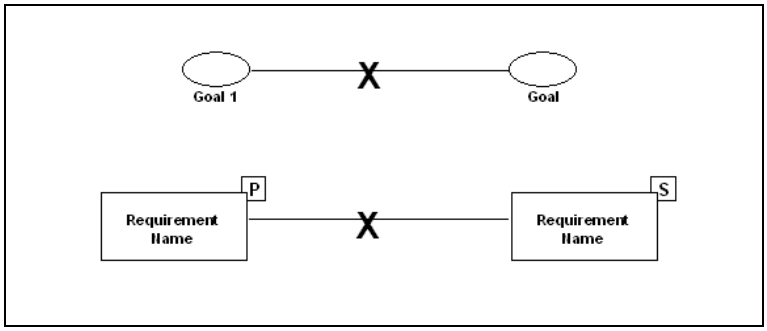


Figure 37. Notation for conflicting goals and conflicting requirements.

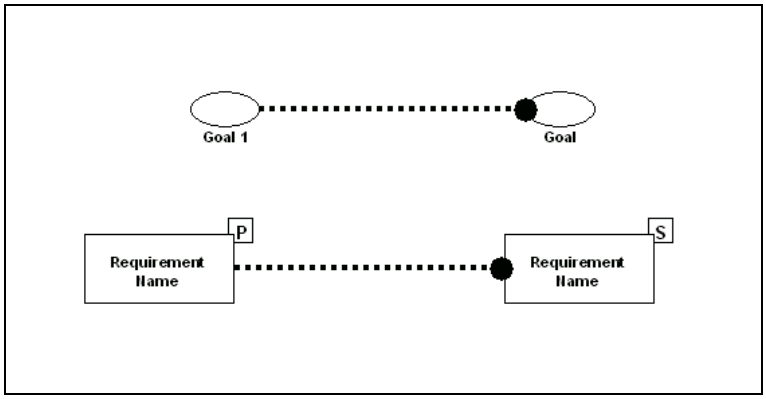


Figure 38. Notation for influencing goals and influencing requirements.

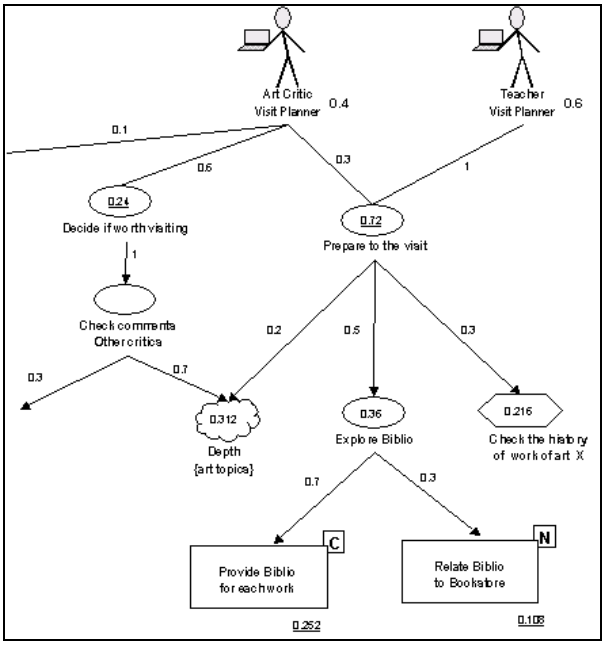


Figure 39. Example of priority propagation from goals to requirements.

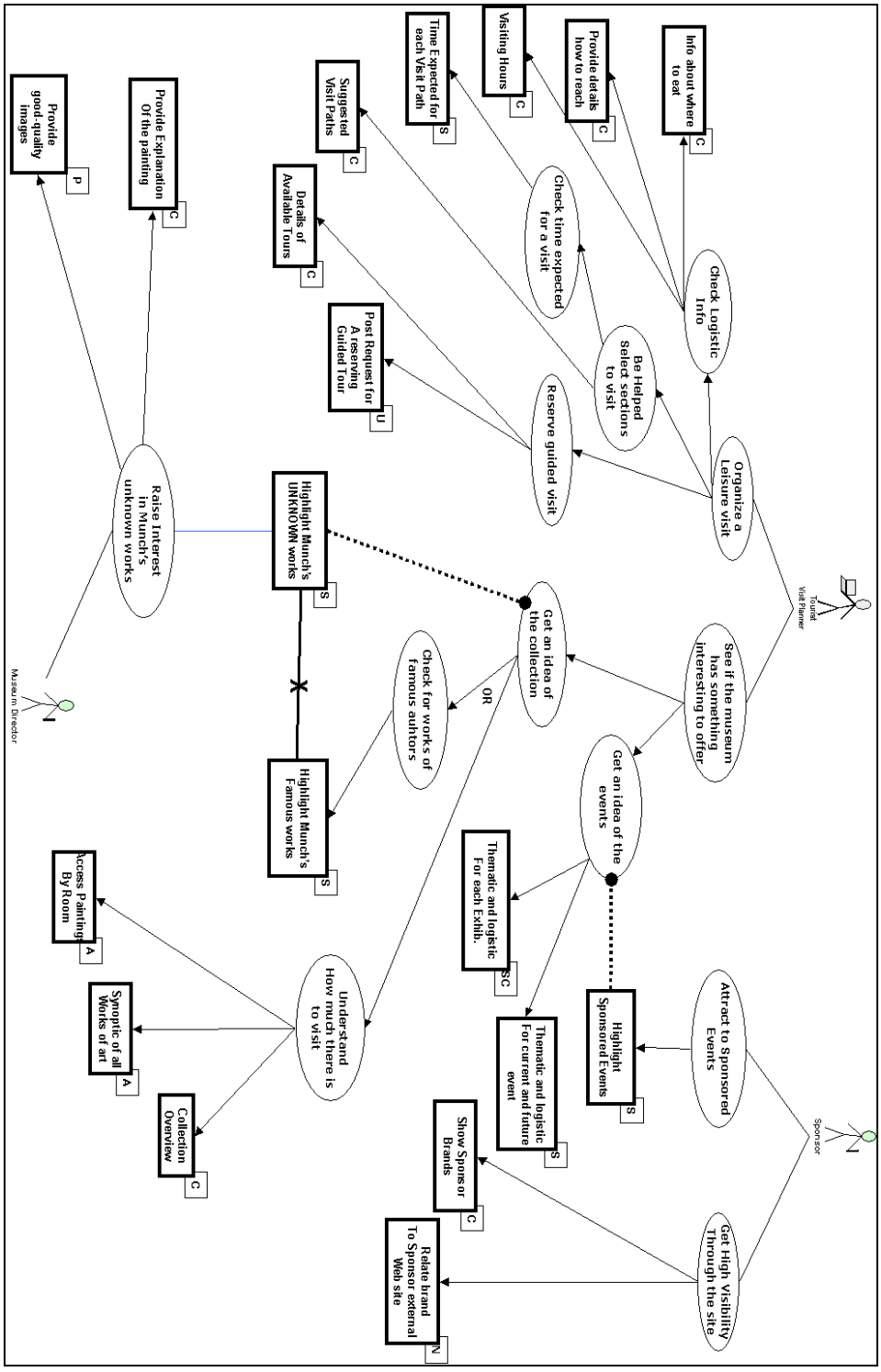


Figure 40. Example of refinement graph.

3.4 Requirements Set

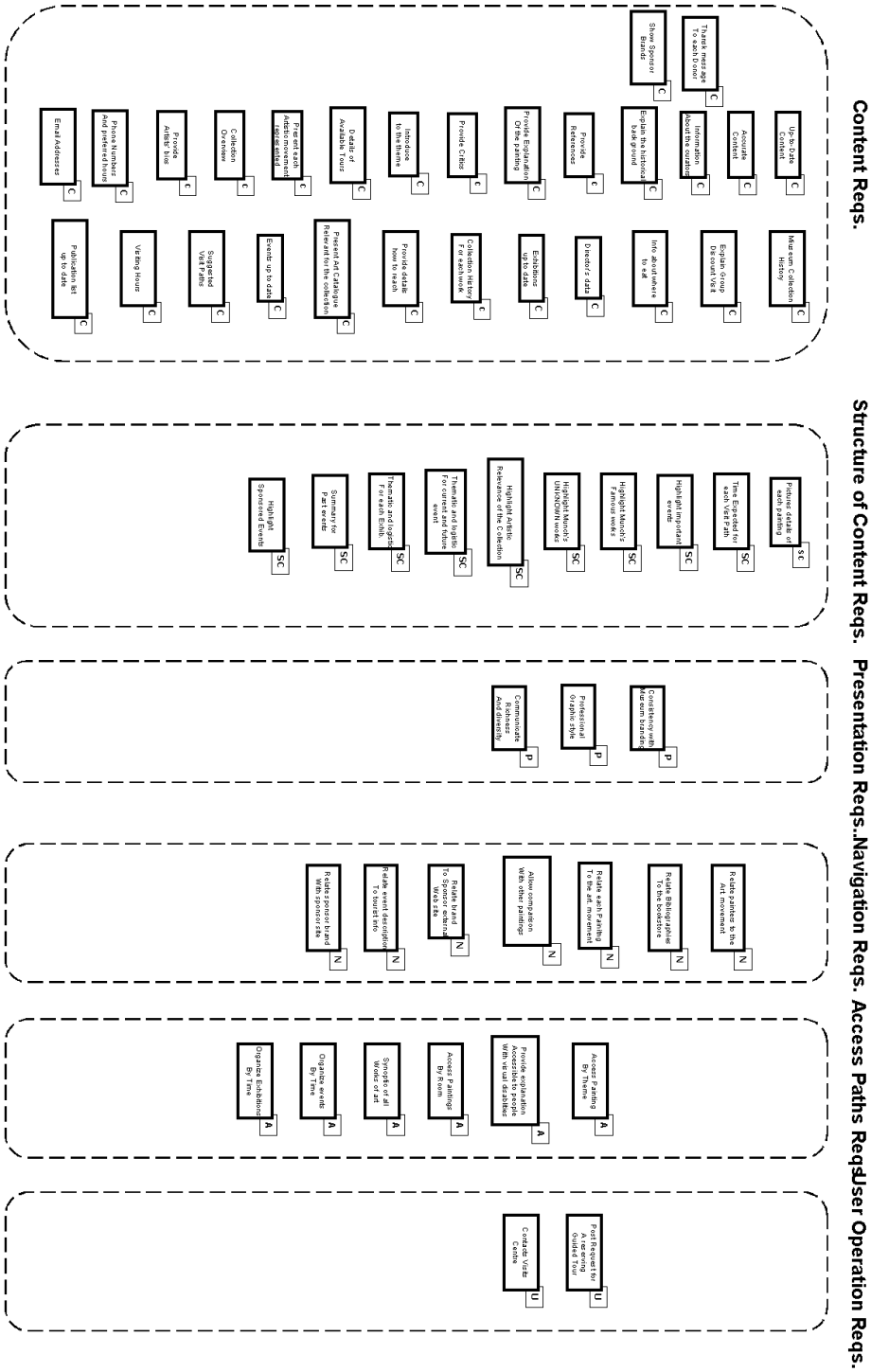
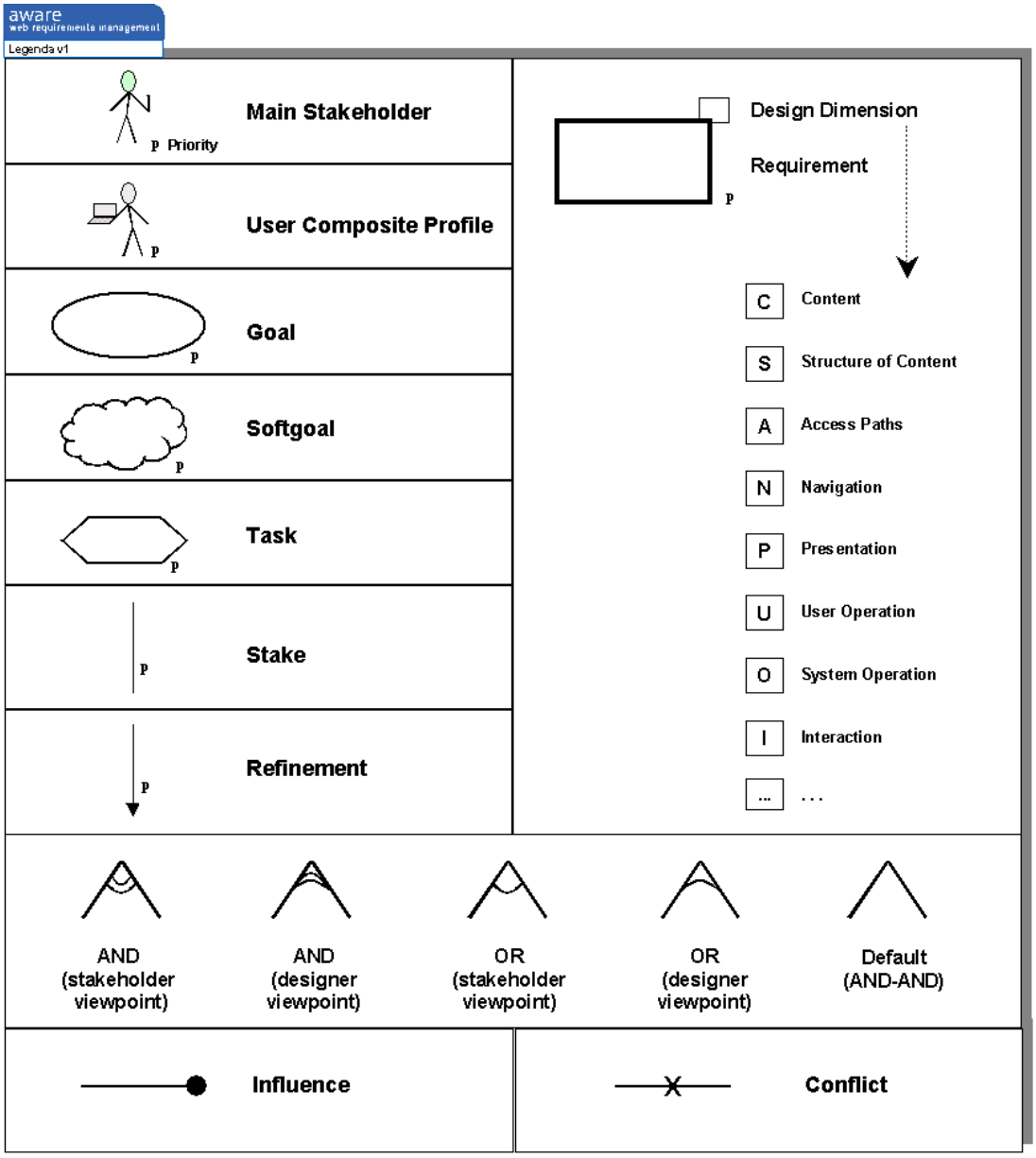


Figure 41. Example of requirements set organized by design dimension.

4 Legenda



Influence and *Conflict* are just examples of more sophisticated goal relationships that may be borrowed by the *i** framework, such as *Prevent*, *Make*, *Help* or *Hurt*.

Annex II

AWARE Project Examples

Abstract

AWARE is a stakeholder-centered requirements analysis toolset that may be used by analysts and designers to conceive goal-oriented web applications.

So far, AWARE has been used on many projects, both in the industrial and research-oriented arena. However, we acknowledge that further validation is needed to demonstrate more exhaustively the effectiveness of all the features of the model.

This chapter reports excerpts from the requirements analysis for real projects carried out using AWARE. They are not didactical examples (like the ones presented in ANNEX I), but real case studies. As such, these case studies have the advantage of representing the outcome of a *real* requirements analysis; however (as it often happens), they have the drawback of not illustrating *all* the features of the model.

The reason for that is two-fold. On one hand, some features of AWARE were developed after the experience gained during the case studies (e.g. the concept of person and roles). On the other hand, each real application has its own distinctive features and thus requires the analysts to focus on some aspects and neglect other that are considered less relevant. For example, for large scale web applications priorities are relevant; for little projects they have little use).

An interesting aspect to note is that in three of the four projects reported, AWARE was used by people who did not develop the model, but were trained – or knew already - about fundamentals of goal-oriented analysis.

As to the notation used in the project reported, it slightly varies from case to case, and it is not fully aligned with the more complete notation illustrated in ANNEX I. Again, the reason for that is the full notation incorporated the lesson learned from the project experiences.

FACT SHEET <project name>[1]	
Artefacts Produced	
# Stakeholders Identified	
# High-level goals	
# Subgoals	
# Hypermedia Requirements	
Effort Spent	
# Analysts	
# men/day	
Tools Used	
% AWARE features exploited	
Editing, CASE tools	

Table 1. Types of analysis data recorded for each project.

For each case study, we present three aspects: the project background, some excerpts from the results of the requirements analysis, and the lessons learned.

In the project background, some data gathered from the application of AWARE to the case study are illustrated by means of Table 1. These data may help to get an idea of the size of the project described, and the effort spent for the requirements analysis.

In the excerpts from the analysis artefacts, some examples of the results of the analysis are illustrated and commented.

With regards to the lessons learned, they express some considerations recorded during the project experience and also reflections *ex-post*. The objectives is to highlight some advantages and weaknesses of the model so as they emerge from the application of AWARE to real projects.

[1] The name of some companies/clients involved in the project are intentionally changed or omitted for privacy reasons.

Table of Contents

List of Figures

List of Tables

1 Banca121 credit card catalogue

1.1 Project Background

The general objective of the UWA project (IST-2000-25131)[2] was to develop a set of design methodologies and tools to support the development of ubiquitous web applications. The methodologies defined comprise of a suite of models for coping with the different aspects of complex web application development: requirements analysis, hypermedia and operation design, customization design, and transaction design. The UWA methodology for requirements represent the fundamental basis for AWARE.

Within the project, two pilot applications were entirely designed and delivered by industrial partners using the UWA methods, in order to assess the effectiveness and the pitfalls of the approach: Punto Comercial electronic market place [UWA, 2002a], and Banca121 (Bank 121, or B121) web credit card catalogue [UWA, 2002].

FACT SHEET **Banca 121**	
Artefacts Produced	
# Stakeholders Identified	7
# High-level goals	16
# Subgoals	12
# Hypermedia Requirements	32
Effort Spent	
# Analysts	3
# men/day	31
Tools Used	
% AWARE features exploited	80%
Editing, CASE tools	MS PowerPoint

[2] UWA (IST-2000-25131 - Ubiquitous Web Application, www.uwaproject.org) is a EU-funded IST project within the 5th European research program framework. The project started on January 2001 and was completed on February 2003.

Between the two applications, the development of Banca121 was the one that used more extensively the features of the requirements analysis method provided. A treatment of the Banca121 application development in the context of requirements engineering is illustrated in [Bolchini, 2002].

Although the features of the model that analysts had at hand were limited – for example user scenarios was not exploited and documented – the analysis conducted represents the first application of the AWARE model to an industrial case.

1.2 Excerpts from Analysis Artefacts

The analysis identified different types of users and bank stakeholders. For example, it was important to differentiate a bank customer having already a credit card from a customer who has not a card yet, because different goals and expectations are associated to each of them Figure 1. This consideration is an example of the need of modelling different user profiles distinguished by characteristics considered relevant for the application design (this aspect will be further elaborated in the concepts of user persons and role).

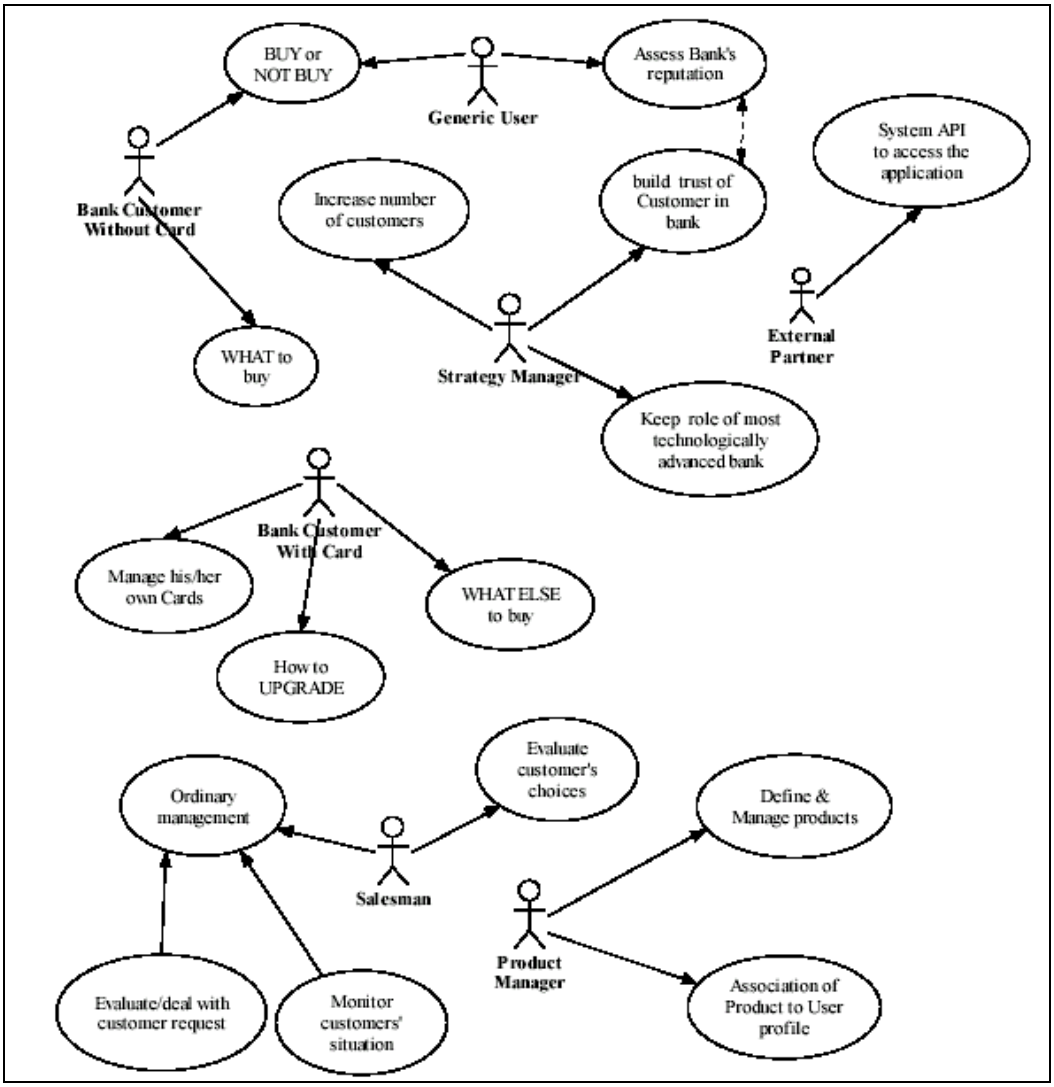


Figure 1. Stakeholders and High-level goals for B121.

Note also the interesting level of abstraction of high-level goals. Goals such as "what to buy", "to buy or not buy", or "what else to buy" express ill-defined goals. In particular, they manifest the needs of the users to be supported in taking decisions about purchases.

Communication and business goals of the bank main stakeholders are also considered. The B121 strategy manager wants to increase the number of customers by means of the website; moreover, he wants also to build trust in bank customers and keep the role of most technologically advanced bank.

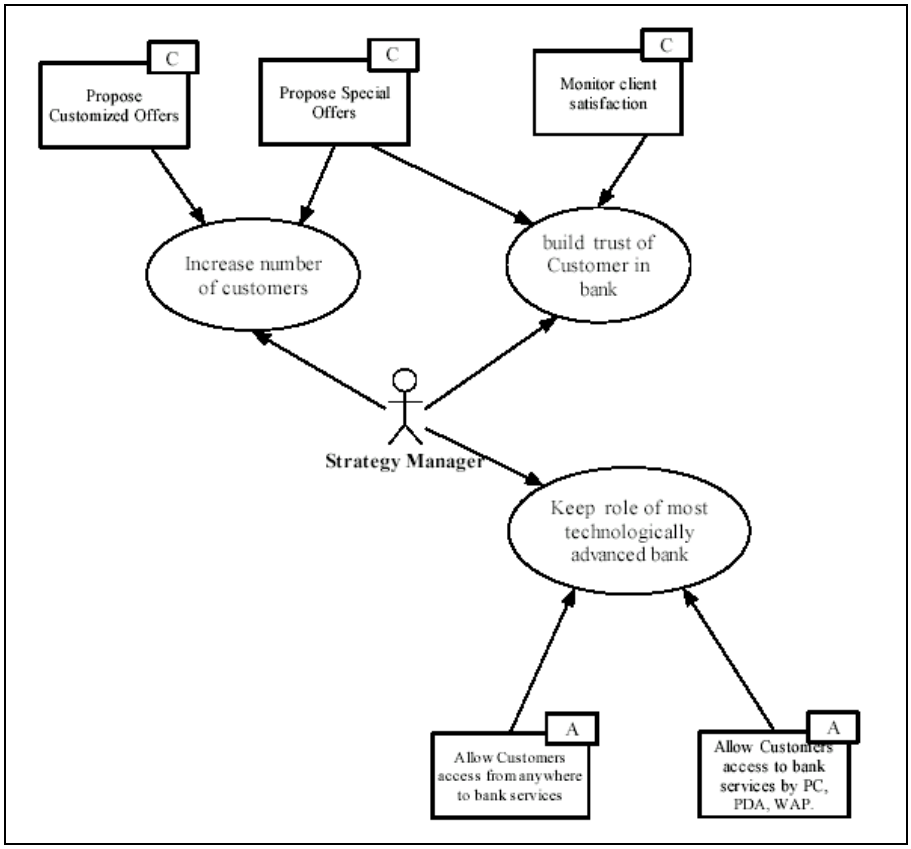


Figure 2. Refining communication goals of the B121 Strategy Manager.

The analysis of the goals of the strategy manager points out clearly the fundamental difference between goal-based analysis and use case analysis. Whereas a use case considers a user interacting with the application functionality, goal-based analysis consider the organization, communication and strategic goals for which the client and main stakeholders - who are not necessarily final users – conceive, build, and plan to maintain the application. As shown in the refinement example of B121, these stakeholder goals have an impact on the final design, because specific hypermedia requirements are derived from them (e.g. “monitor client satisfaction”, “propose customized offers”, or “provide ubiquitous access”).

1.3 Lessons Learned

The analysts that carried out the analysis provided insightful feedback about using the requirements analysis model. Hereby, we will report some of the most significant observation gathered from this project experience.

Stakeholders may define goals owned by other stakeholders

Quoting from the comments made by the analysts [UWA, 2002]: *"a stakeholder tends to express not only his/her own goals and requirements but also the goals and requirements of other stakeholders. It is important at this stage to attribute the goals to their respective stakeholders, without being influenced by the point of view expressed by a stakeholder in relation to goals attributed to another stakeholder. A stakeholder might give an inaccurate interpretation of the goals of another stakeholder"*.

Requirements and customization

The relationship between requirements analysis and the customization of the website to different delivery channels and different user types is still an open issue. Analysts states this problem in the following terms: *How should customization (for example with respect to devices) be managed? Should this be taken into account at requirement level (developing various requirement documents from which to derive a single or a series of design documents), or only in the design phase (a single requirement document from which to develop various design documents)?* [UWA, 2002].

Goal-analysis is more than use-case analysis

Goal-based analysis has a wider scope than use case analysis. Goal-based analysis considers the goals of important stakeholders who are not users, whereas use cases focus only on the actors who will interact with the website.

Moreover, use cases model actors interacting with units of functionality of the system, and therefore they already assume that a number of design decisions about the system have been taken. Goals instead express wished states of affairs at a higher level of abstraction, enabling the exploration of strategic alternatives and the definition of ill-defined expectations.

Requirements granularity depends on designer's knowledge

In the B121 example, requirements were defined by analysts who had a long-standing design experience on systematic methodologies for web design. As a result, the hypermedia requirements taxonomy was used without major difficulties. However, analysts pointed out that this may be not always the case. The level of granularity of the

requirements largely depends on the knowledge and the conceptual tools available to the designers [UWA, 2002].

2 B-silver Website

2.1 Project Background

In April 2002, the requirements analysis for the web site of an Italian supplier of silver-made artefacts (from now on called B-silver) was carried out.

We adopted the AWARE model employing a more informal, stakeholder-oriented graphical representation. It is structured (to communicate with designers) but simple and semi-formal (to communicate with clients). In this simplified format, requirements are visually "labeled" according to the hypermedia taxonomy and goals are mainly considered in "and" relation. In this section, an excerpt of the artefacts defined during the requirements analysis will be discussed [Bolchini, 2003].

FACT SHEET B-silver	
Artefacts Produced	
# Stakeholders Identified	2
# High-level goals	6
# Subgoals	16
# Hypermedia Requirements	15
Effort Spent	
# Analysts	1[3]
# men/day	3
Tools Used	
% AWARE features exploited	85%
Editing, CASE tools	MS PowerPoint

The project was small: it involved one novice analyst (with an good knowledge of AWARE) and one stakeholder (the president of B-silver). Two meetings with the stakeholder were held. The first meeting was devoted to eliciting the vision, the high-level goals, and the project contractual constraints. Then, the analysts elaborated goals,

[3] In this project, AWARE has been used by Davide Bolchini, the main author of the model.

requirements and user scenarios using AWARE notation, trying to interpret the material gathered in the first meeting. In the second meeting, the analyst discussed, negotiated, changed and validated results with the stakeholder. This second meeting led to a final version of the requirements specification, which is presented in the next paragraph.

2.2 Excerpts from Analysis Artefacts

2.2.1 Goals of the Firm

The crucial high-level objectives that B-Silver needs to address by means of the web site are:

- *Attract New Clients*. B-Silver is one of the leaders in the regions near to its location. However, the company planned to acquire new silver resellers in other Italian regions. The site could be a useful communication tool to contribute to this strategy.
- *Facilitate Contacts*. The site should serve as an easy-to-reach resource for potential and current clients to get in touch with B-silver.
- *Communicate Corporate Identity*. B-Silver has a corporate identity based on a long tradition of style and quality in the Italian panorama of silver suppliers.

On the solicitation of the analyst, the B–silver president prioritized the goals in a discrete range from 0 to 1. Such priorities values justify that one of the main reasons by which B-Silver wants to have a web site is to attract new clients to its business. The president decided that the goal “Attract New Clients” is more important than the others because the firm is investing for gaining market share in other regions.

The base of customers has to be enlarged and the web site is seen as a powerful tool to contribute to this end.

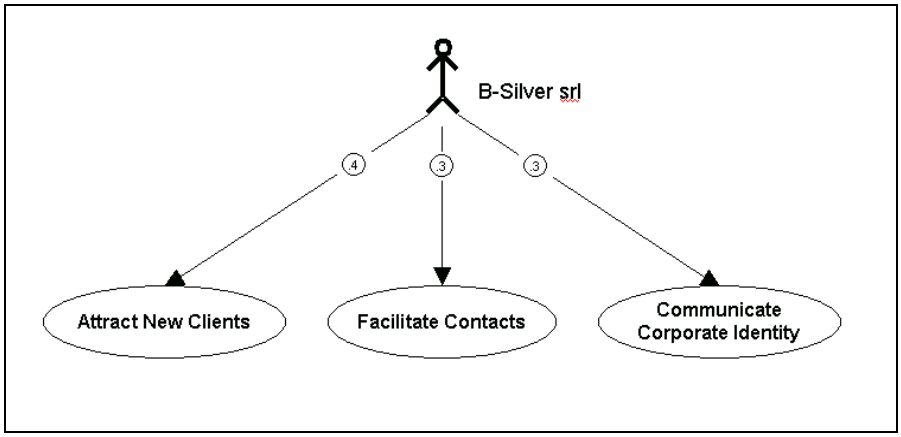


Figure 3. The highest-level goals of B-Silver.

Goals are in "and" relation in the sense that the web site should be a tool to allow B-Silver to satisfy all these three goals. In this simple case, since there is just one stakeholder on the B-Silver side, a priority 1 (not marked) has been assigned to the president.

Let us consider the analysis of the most important goal, namely *Attract New Clients*. During the meetings with the president and his staff, it emerged that the most reasonable strategy for B-Silver to convince potential web site visitors to become clients is to communicate the critical success factors of B-Silver in the silver supplier market. Furthermore, these were identified in having a store with very large assortment of products, making product available in a short time and offering repairing and restyling services.

It is clear that the fulfilment of the *Attract New Clients* goal relies also on the promotional strategy (online and offline) of the web site (registration and keyword-buying on search engines, merchandising, and newsletters). This aspect, which is not strictly related to the design of the web application but to its promotion, is intentionally not documented in the requirements analysis directed to designers.

All three sub-goals identified should be analysed and further decomposed. Decomposition here is not intended as a necessary derivation, but rather as the documentation of the outcome of a decision-making process.

Elaborating on *Store with Large Assortment* sub-goal, two goals were identified: *Highlight the Variety of Products* on one hand and *Avoid Presentation of the Single Item* on the other. The latter sub-goal is a case of negative goal (also called "Avoid" goal). Indeed, the discussion with the staff of the president gave raise to the belief that B-Silver does not intend to present on the web site the details of each single product available in the store. It is not reasonable to manage the presentation of more than hundreds

thousands products on the B-Silver web site, mainly for prohibitively expensive costs of content production, maintenance and updating.

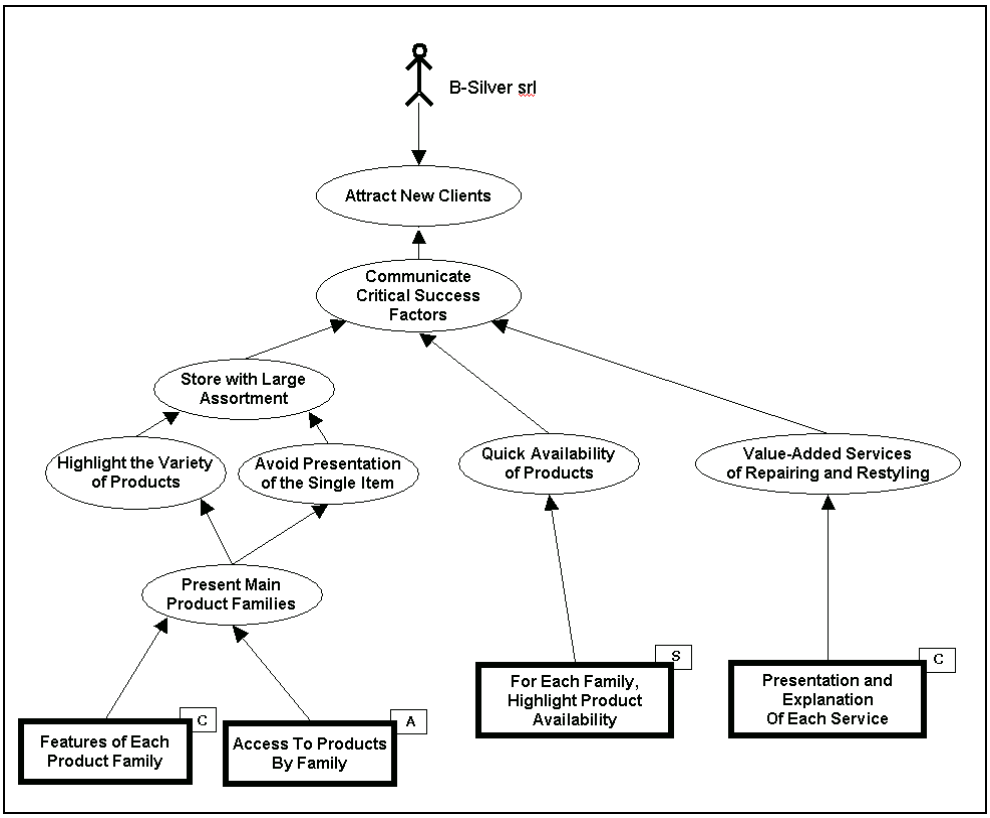


Figure 4. Analysis of the "Attract New Clients".

In order to solve the tension between *Highlight the Variety of Products* and *Avoid Presentation of the Single Item*, a possible strategy identified is to *Present Main Product Families*. With such strategy, the communication of the range of different products is ensured without affecting dramatically the budget available. Two requirements are defined to fulfil *Present Main Product Families* goal: a content requirement (labelled with C) stating that descriptions of the features of each product family has to be provided; and a requirement saying that the user might be able to access the products "by family". The latter requirement concerns the "Access" aspect of the web site design and is then labelled with A.

In order to communicate that B-Silver makes products available in a short time (*Quick Availability of Product* goal), the requirement defined is to highlight the average time of product availability for each product family. This is a requirement concerning the structure of content (labelled with S) because it states that, in the context of the

description of the product family, the information about availability should be particularly visible.

Two content requirements capture the information needed to *Facilitate Contacts* with B-Silver. It is important to note that such requirements do not anticipate design solutions because they just identify the content needed.

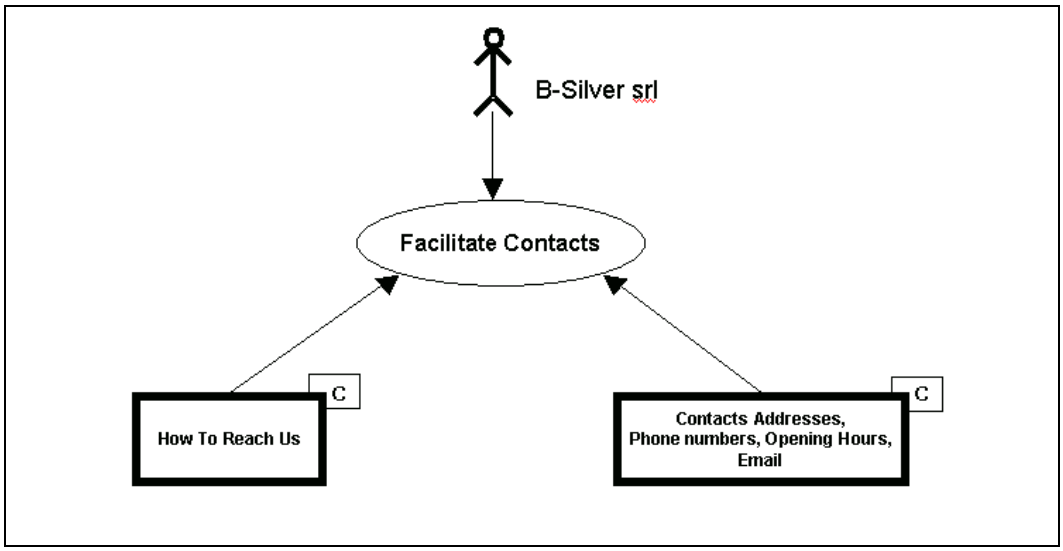


Figure 5. Analysis of "Facilitate Contacts" goal.

The communication of B-Silver corporate identity is achieved through three basic requirements: the site will clearly explain that B-Silver will not sell artefacts to private clients (refining "Communicate Supplier Role" goal); moreover, it should be communicated that the store is located in the centre of the city of Milan (refining "Communicate Milan-based" goal). As third requirement, concerning the presentation aspect (labelled with P), the site should have a presentation style (in term of graphics and layout) consistent with B-Silver corporate brand image.

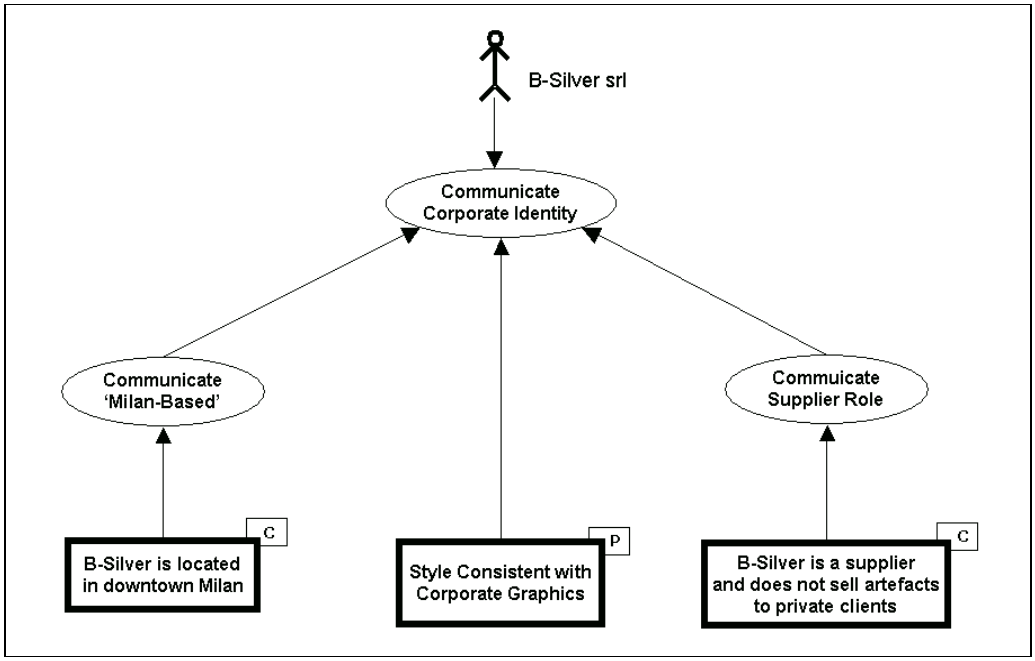


Figure 6. Analyzing "Communicate Corp. Identity".

Through this analysis, the analysts gathered a first set of essential hypermedia requirements and the basic rationale behind them. As crucial complement to the analysis, the next paragraph will discuss the definition and the elaboration of users' goals, which will dictate new requirements for the web site.

2.2.2 Users' Goals

Obviously, the public area of the web site is potentially accessible by any web user. However, any communication act presupposes an intended target audience. The more the characteristics and the expectations of the addressee are known, the more the communication act has chance to succeed. User requirements analysis should define the specific desired users to address and anticipate their goals, in order to deliver a satisfactory user experience and achieve the communication objectives.

Among the different user profiles envisioned by B-silver president, one emerged as the most important (and the only) to be taken into account in this case: a 40-50 years old manager of a small or medium Italian jeweller with a discrete familiarity with Internet sites. This user profile models that community of users that represents the main target audience of the communication strategies envisioned in the previous analysis. In fact, it also represents the profile of the typical B-Silver client.

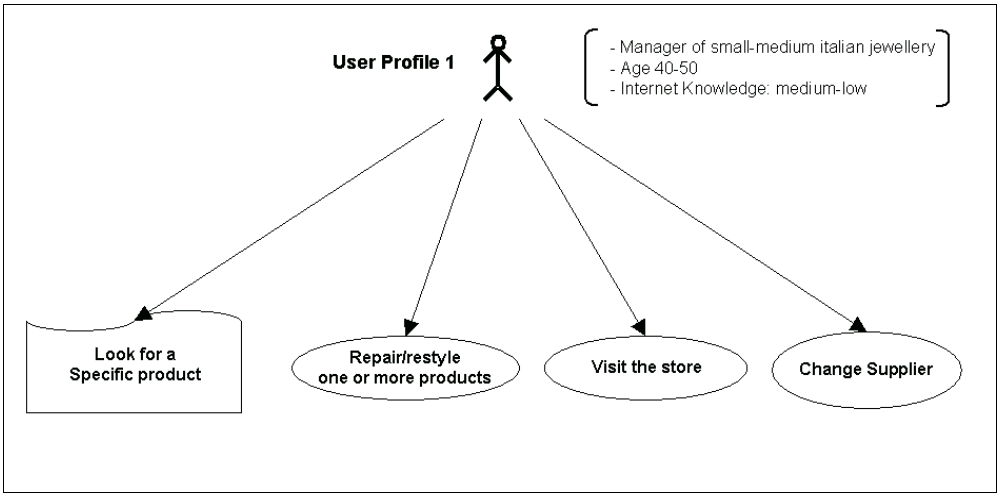


Figure 7. High-level view on user's goals.

Given these basic features, User Profile 1 models a variety of user types. This profile may represent either a potential client of B-Silver or someone who is *already* a B-Silver client. Moreover, both users should be taken into account as *first time visitors* or *experienced users* of the site. Whatever combination of user types is considered, the analysis focused on User Profile 1 as representative of those user types sharing a set of goals or tasks.

Envisioned high-level goals for the User Profile 1 are: repairing or restyling one or more silver products, visiting the B-Silver store, and being persuaded to change the current silver supplier. Moreover, User Profile 1 might also want to look for a specific product on the web site. This is considered a *task* rather than a *goal*, because it does not express a wished state of affairs for the user but rather a user activity on the site.

Any given combination of User Profile 1 and goal (or task) is the essence of a *user scenario*. During analysis, scenarios have been envisioned in more narrative form, specifying further the user type considered, detailing the context of use and adding details about the goal to be accomplished. Then, to document the salient scenarios and smoothly represent the results of the scenarios analysis similarly to the previous goal analysis, a more synthetic and schematic notation has been chosen. This choice also facilitated the discussion with the stakeholder. Tasks and users' goals are in "and" relation in the sense that the site must support all the goals and tasks defined.

The task *Look for a Specific Product* cannot be supported in this case by access structures typically employed for comprehensive product catalogues (e.g. lists of all product instances or search engines) because just the families of products (and not the single product info) are presented Therefore, from each product family, it is possible for

the user to navigate to a related area to request if the desired product of that specific family is available in the store.

The goal *Repair/Restyle one or more products* is refined into the user task *Look if repairing services are offered*. The requirement defined to support this task concerns a structural aspect of the site content: *Highlight Added-Value Service Offered*. This requirement means that the user should be easily guided to locate the repairing services description within the site. This requirement actually adds structural information to a requirement already defined in the stakeholder analysis: *Presentation of Each Service Offered*.

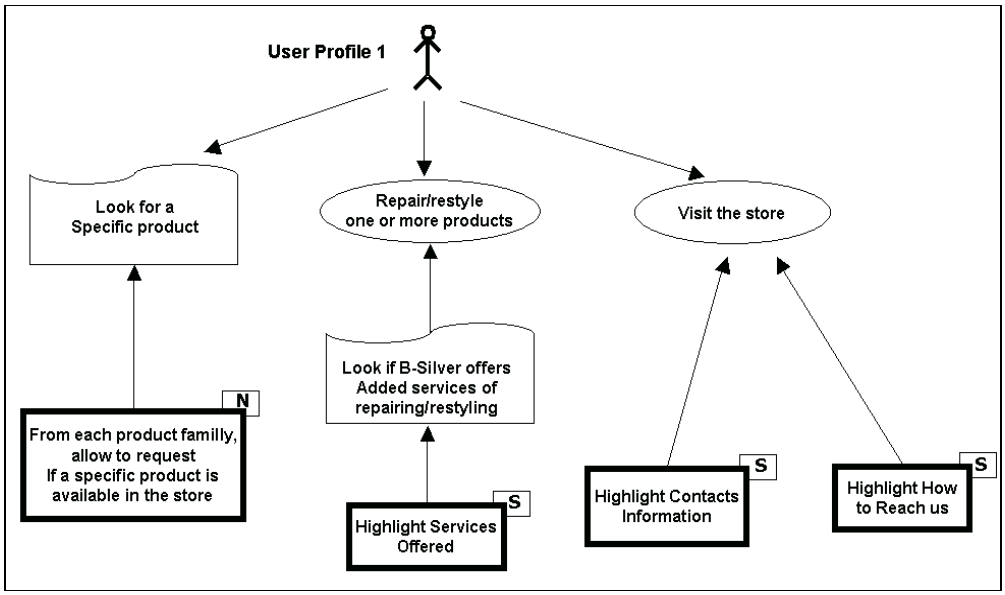


Figure 8. Analysing user's goals.

The requirements defined to satisfy the *Visit the Store* goal partly match with the ones discovered in the stakeholder goal-analysis but, in addition, they state that these pieces of content should be particularly highlighted for the user. The design activity will then decide *how* this "highlight" will be solved, according to the economy of the overall site structure and design style.

The goal *Change Supplier* enabled to elaborate three further salient scenarios discussed with the stakeholders. User Profile 1, in order to change supplier, might want to look for a more punctual partner, or one might be looking for a larger assortment because the current supplier does not satisfy the diversified needs of his/her clients. In a third scenario, the potential client might be interested in finding a supplier with a better quality/price ratio. These three scenarios have been refined consequently in tasks and then into hypermedia requirements.

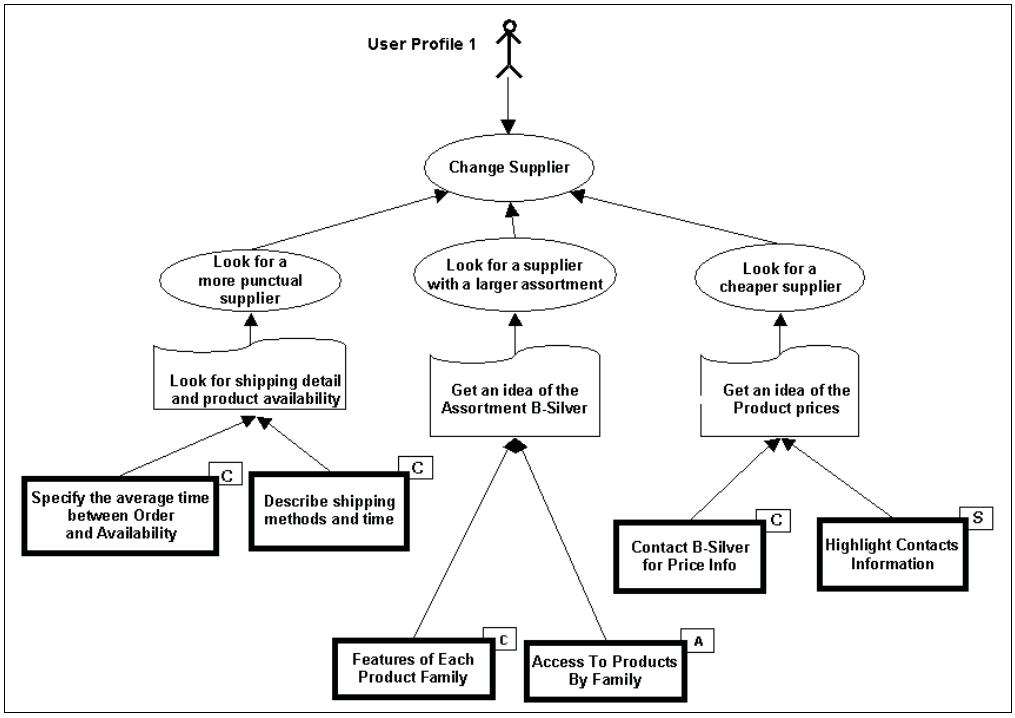


Figure 9. Defining requirements for "Change Supplier" user's goal.

The user's goals analysis allowed partly to define new requirements and partly to match already stated requirements with user needs.

2.2.3 Requirements Set

The requirements set for B-Silver website have been organized by design dimension:

Content

- Features of each product family
- Presentation and explanation of each service
- Information about how to reach the company
- Contact information
- B-silver is located in downtown Milan
- B-silver is supplier and does not sell to private clients
- Specify average time between order and availability
- Shipping methods and time

Structure of Content

- For each family, highlight product availability
- Highlight services offered
- Highlight contact information
- Highlight how to reach us

Access

Access products by family

Navigation

From each product family, allow to request the availability of a product

Presentation

Style consistent with corporate graphics brand

As it is shown by this list of requirements, the analysis identified mainly requirements concerning the content to be offered by the site. As to the other dimensions, the requirements provided just general and partial indications.

The design activity will fill in the gaps left by requirements analysis, clarifying better the requirements by proposing complete design solutions.

2.2.4 Design Examples

In the real case described, the level of detail of requirements may serve both as input for a systematic hypermedia design and for totally informal and non-structured approaches to web design (which most practitioners adopt).

We used a systematic web design technique (called W2000 [UWA, 2001], an evolution of HDM [Garzotto, 1996]) for elaborating design solutions on the basis of the requirements. W2000 is a schema-based conceptual design model for content-intensive web applications that - similarly to a variety of other design models - offers conceptual constructs to define the information design, the navigation design, the publishing design, and the operation design. We will not go into the details of W2000, that is a proven design method that is fully described in [UWA, 2001]; however, as examples, we report some excerpts from the hypermedia design carried out for B-Silver.

2.2.4.1 Information Design

According to W2000, the task of information design is to shape, on the basis of the content, navigation and structure requirements, the information architecture of the web application. A basic artifact of information design is the hyperbase schema in-the-large (Figure 10) which defines the main information objects available to the users (entity types and single entities), and the semantic associations that may be exploited for navigating from one object to another. Each entity is marked with the expected number of instances for that entity.

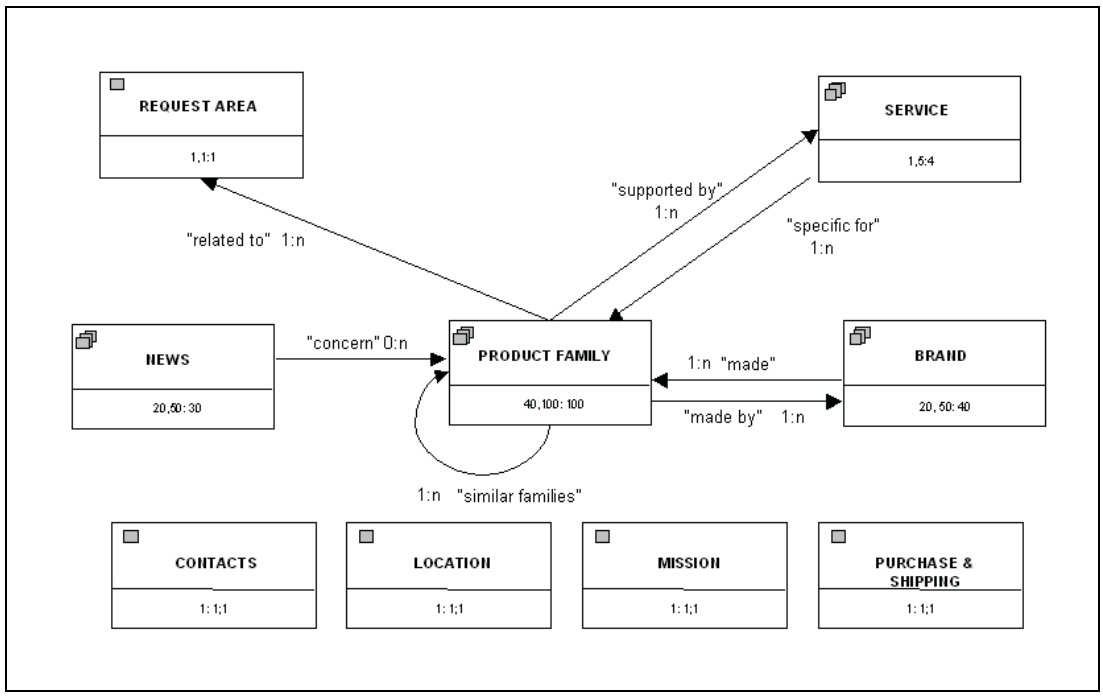


Figure 10. Hyperbase schema for the B-silver website.

The hyperbase was basically defined on the basis of the content and navigation requirements. However, at this stage only, new navigation capabilities emerged as relevant to offer to the user, which had not been envisioned at the requirements stage. For examples, the possibility of navigating from a family to similar product families, or to the description of the brands of the product family were defined and discussed with the stakeholders at design time. From this experience, we learned once again that having a high-level design allows quick and inexpensive iteration between requirements and design documentation.

Information design comprises also the definition of the access structures available to the user to locate and reach the content of interest. In the W2000 framework, entity types are grouped in collections for the purpose of access (see Figure 11).

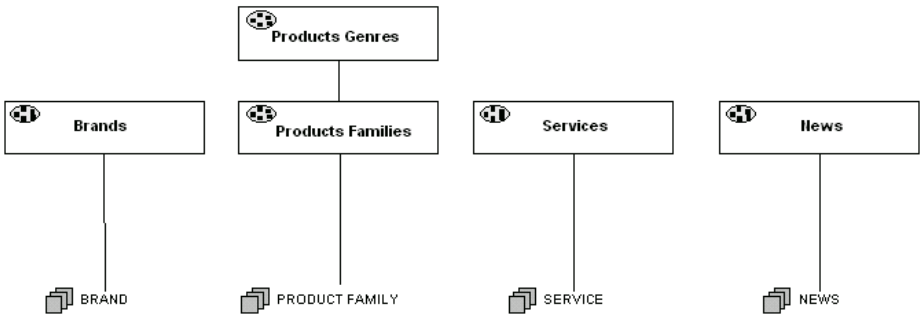


Figure 11. Collection Schema for the B-silver website.

As we consider the detailed content of the site, we have to define the information components of each entity type. Figure 12 shows the information components and the detailed information slots for the entity type Product Family.

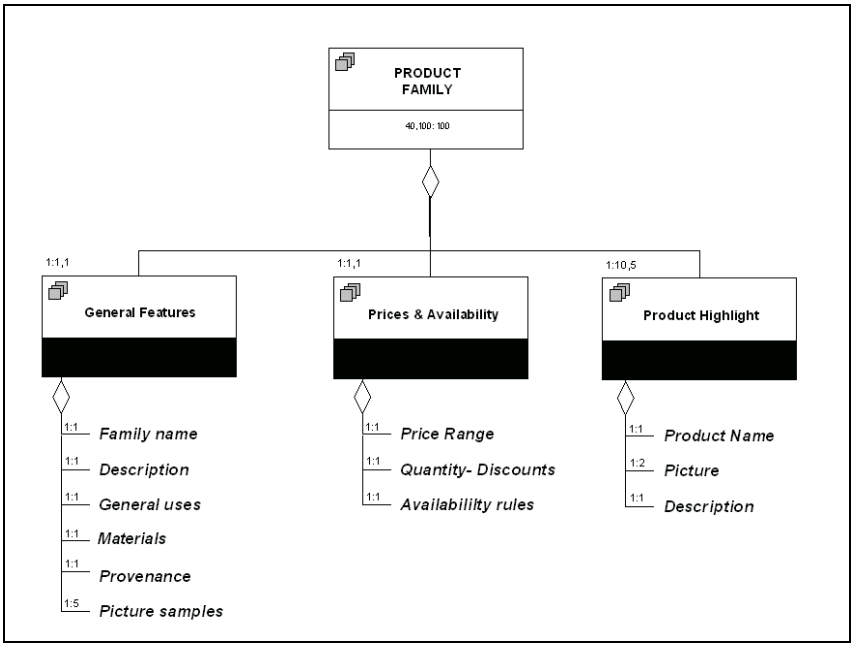


Figure 12. Information Components for the entity type Product Family.

Note that the information components do not describe any predefined user interaction or navigation structure. They just state the needed content for the information object. In fact, given the same information structure, different navigation paths may be designed on top of it. To this end, navigation design enables to define the web site in terms of nodes and links derived from the conceptual object of the information design.

2.2.4.2 Navigation Design

Navigation design aims at defining the detailed navigation contexts (called *Clusters*) for the user to interact with the nodes and links composing the website. Clusters have to be defined for each type of navigation context to be supported: the semantic navigation between entity types (association clusters), the navigation within an entity type (structural clusters), and the navigation within a collection (collection clusters)

Let us consider two simple examples of navigation clusters, a structural and a collection one. Figure 13 shows the navigation cluster designed for the entity type Product Family. The components of the information design have been reorganized in nodes for the user to navigate, and navigation patterns have been defined between nodes. In simple cases, it may happen that components and nodes have a one-to-one correspondence. In this case, to avoid cognitive information overload, the content of the component *Prices and Availability* (Figure 12) has been divided in two navigational nodes, namely *Availability Info* and *Prices and Discount* (Figure 13). Another important navigation design decision that has been taken concerns the creation of one node for each *Highlight Product* information, and the definition of a suitable navigation pattern for allowing both guided tour access to this content (for example for first time users) and direct indexing (preferred by frequent users).

In W2000 terms, a cluster of an entity is called a structural cluster, because it defined the navigation paths enabling to explore the structure of an information object.

Note that navigation design defines clusters are navigational context *types*, that will be instantiated according to the instances of its elements. In this example, each instance (100 overall) of the entity type Product Family will be organized according to this navigation dynamics.

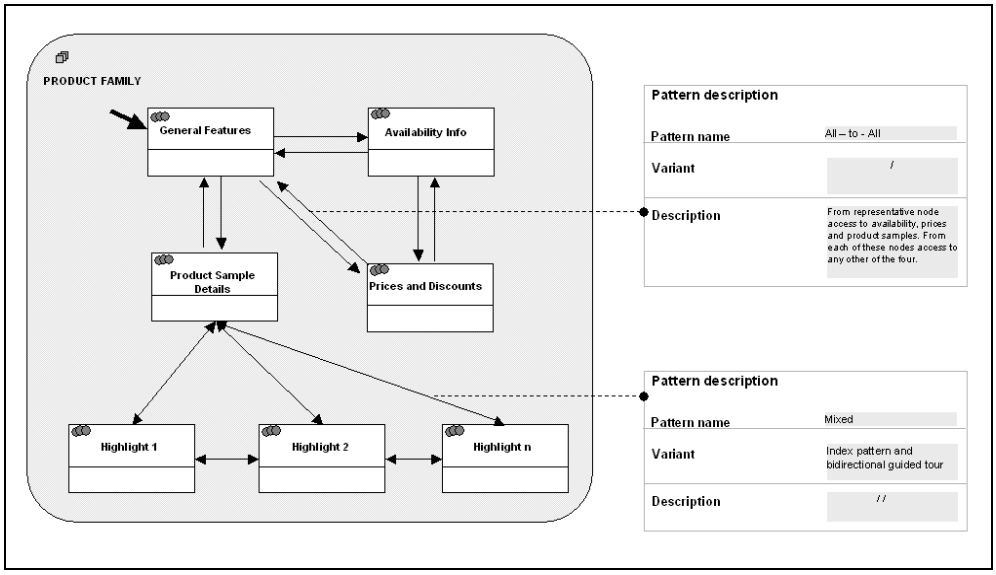


Figure 13. Navigation Cluster for the entity type "Product Family".

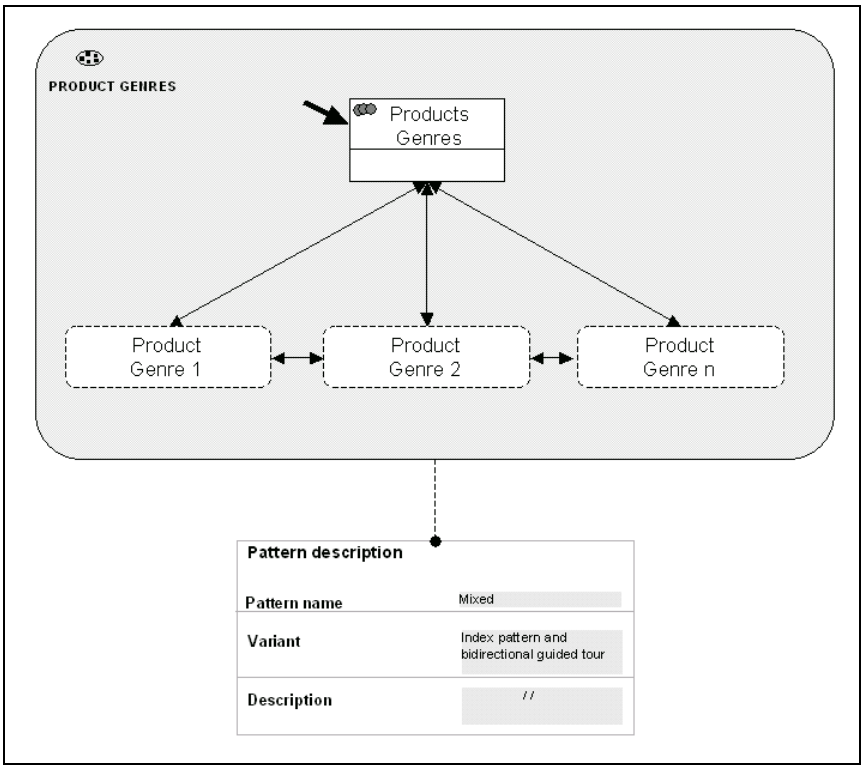


Figure 14. Collection Navigation Cluster for the collection " Product Genres".

Figure 14 shows the detailed navigation for the collection cluster of the collection Product Genres. In this context, designers define paths for the user to explore the different product genres. Links and navigation patterns from the entry point node of the collection to the collection members are designed.

2.2.4.3 Publishing Design

Once all the navigation clusters have been defined in terms of nodes and detailed linking, it is possible to decide how nodes and links will define the actual web site pages. The logic structure of the pages are designed in terms of page types and page sections. A page type is composed by page sections. A page section may include links and one or more content nodes. Figure 15 shows the logical structure of the page type for the node General Features of the entity type Product Family.

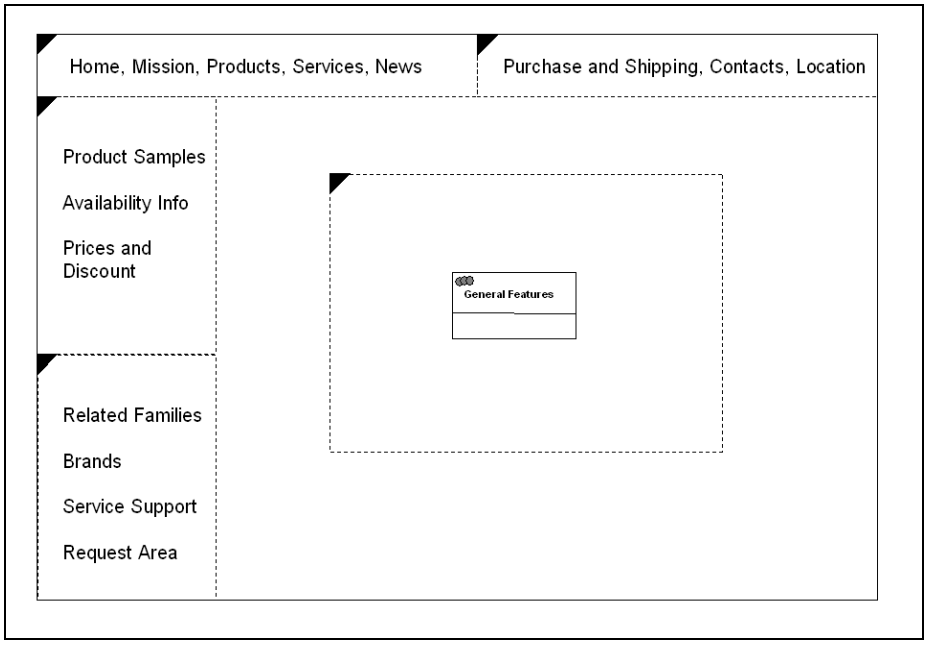


Figure 15. Page type of the node "General Features" of the entity type "Product Family".

This page type is made by five sections, each one providing outcoming navigation links from the page, in compliance with the navigation design. Page section suggest tentative organization of the material on the page, but they do not define a graphic layout. Detailed layout mock-ups and graphics proposals may then be made on the basis of the page type design.

2.3 Lessons Learned

Conceptual design completes and clarifies requirements

Requirements analysis may be not complete, because it focuses on key requirements. During conceptual design, by elaborating the requirements into the overall economy of the design, new features to the site are added, tactical decisions may be made and the requirements are detailed, thus connecting the functional solutions in a coherent whole. In this sense, it may happen that the design fills in the gap left by requirements analysis whose main task is to focus on the general strategy (goals), rather that on the detailed tactics.

Goal-analysis is rewarding also for small projects

Even for small projects, characterised by limited budget available, AWARE can support communication and discussion with stakeholders about the high-level objectives of the site. In the case study, the stakeholder was gently "forced" to reason about the objectives he wanted to achieve by the means of the website, rather than on focussing on superficial considerations and preconceived design details (e.g. about graphics animations, page layout).

Site scenarios are needed for impact analysis

Without prototypes or mock-up-based scenarios available, it is difficult for the stakeholders to get a clear picture of how the requirements will impact the final site. In the case study, whereas the analyst could implicitly figure out possible designs descending from the requirements as the requirements were defined, the stakeholder had difficulties in vividly seeing how all the requirements would make a coherent solution. Scenario-based prototypes (and not only narrative scenarios) may be useful during the analysis to communicate partial but vivid design solutions and to see the impact of the requirements on the user experience.

Goals make stakeholders focus on the users

Showing user goals to stakeholders during the requirements analysis can educate stakeholders to focus on the target audience of the communication and to its overall usability during the formulation of the site objectives. This is not an obvious consideration. Clients tend to favour their own perspective on the website, figuring out how *they* may use the website. However, prompting user scenarios and user goals clearly shows them that they are not the users, and that real users have different needs and expectations from what the client wants and expects.

Basics of AWARE are easy to understand

In the context of the case study presented, AWARE turned out to be easy-to-understand for stakeholders with no engineering background. Thanks to its intuitive notation and concepts, the client played an active role in the discussion of goals and requirements.

The role of negative goals

A negative goal is not only a negation of a final state of affairs in the real world, but it may be the declaration of the intention of not following a given communication and design strategy.

AWARE supports elicitation, analysis and validation

AWARE may be effectively used by analysts for different activities of requirements management. In the case study, AWARE was used for three important activities. It was used to organize the material gathered during *elicitation* with the stakeholders. It was used to *analyse* and refine requirements without the stakeholders. Finally, it was used to *validate* the analysis results with the stakeholders.

3 The Portal for the Italian Culture

3.1 Project Background

On April 30th 2002, a feasibility study for a web portal of the Italian culture was completed on the commission of the Italian Ministry for Cultural Heritage [HOC, 2002]. The project was coordinated by Prof. Franca Garzotto from the Politecnico di Milano (HOC -Hypermedia Open Center), with the cooperation of EB lab (Electronic Business Laboratory of the Politecnico di Milano), Tec Lab (the Technology-Enhanced Communication Laboratory of the University of Lugano) and Set Lab (Università di Lecce).

The study was intended to be an analysis of the organizational, communicational, and technological scenarios that might sustain the design, development and maintenance of a web-based portal of the Italian culture.

The process for the completion of the requirements elicitation and analysis and was organized in parallel activities: meetings and interviews with a core working group of the Ministry, interviews with technical personnel of the Ministry, interviews with the top executives of the Ministry, meetings with executives of publishing companies and potential content providers, analysis of major public websites in the Italian cultural heritage field, and questionnaires shared among other stakeholders and opinion makers. The work was conducted with the effort of approximately 10 man/months over a period of 4 months.

As a result, a substantial part of the feasibility study – comprising potential benefits and pitfalls of the project, business and organizational solutions, and technological scenarios - was devoted to the elicitation and analysis of goals, expectations and requirements for the design of the portal. The final document of the study [HOC, 2002] is a high-quality communication tool for conveying to the Ministry the results of a empirical and analytical requirements analysis. The methodology adopted for the requirements analysis is AWARE in its initial version. The methodology adopted for the design guidelines is W2000 [UWA, 2001].

FACT SHEET Portale della Cultura Italiana	
Artefacts Produced	
# Stakeholders Identified	129
# High-level goals	9
# Subgoals	20
# Hypermedia Requirements	♣
Effort Spent	
# Analysts	10
# men/day	300
Tools Used	
% AWARE features exploited	95%
Editing, CASE tools	MS PowerPoint & Word

3.2 Excerpts from Analysis Artefacts

In this section, we report only one of the many aspects contained in the study that are of methodological interest for requirements engineering.

As part of the exploratory part of the study, a questionnaire was designed to survey expectations and goals with respect to the portal. The questionnaire was given to 129 stakeholders. The main subjects surveyed belong to the following institutions: a) Italian regions; b) general directorates of the Ministry, c) peripheral structures of the ministry, d) Universities, Research Centers, Publishing Companies. Thirty-three (33) filled questionnaires were returned (24% response rate).

The results obtained show the aggregated *priorities* that stakeholders assigned to the high-level goals of the portal, to specific functional and non-functional requirements, and to the main target audience to address.

♣ In the documentation of the study, subgoals were gradually translated in high-level structured guidelines for the information design of the portal. Therefore, the elements of information design in-the-large correspond to the granularity level of the requirements identified in the other projects presented.

Let us consider some examples. In the following tables are reported respectively the issues investigated (with the options offered), the average of the responses (normalized to 100), the mapping of the responses to a four-value scale (A, B, C, D[4]) in decreasing order of importance, and the standard deviation.

Stakeholders prioritized the high-level goals of the portal as showed in Table 2.

High-level Goals	Average	Synthesis	Std. Dev.
a) Provide a presentation showcase of the panorama of the Italian culture (generic introduction and overviews).	***8,81***	***B***	***12,94***
b) Tell the "venues" of the Italian culture (museums, churches, etc.)	***13,98***	***A***	***12,08***
c) Provide contacts for the cultural operators in Italy.	***9,46***	***B***	***8,03***
d) Guide through the Internet presence of the Italian culture (guide to selected sites, updates, reviews, etc.).	***15,28***	***A***	***13,13***
e) Promote the cultural events (current and future) in Italy (exhibitions, festivals, concerts, etc.)	***12,99***	***A***	***9,27***
f) Provide advanced services for booking events and purchasing merchandising.	***9,67***	***B***	***9,21***
g) Offer a communication tool for the management of the Italian cultural heritage.	***8,75***	***B***	***8,55***
h) Provide a tool for the everyday work of cultural operators and tourist operators.	***10,61***	***B***	***10,12***
i) Being a searching tool for students, researchers and scholars.	***10,44***	***B***	***8,21***

Table 2. Priorities for high-level goals of the portal.

The following table reports the responses about non-functional requirements concerning the content of the portal. As such, the options represent high-level softgoals for which stakeholder express their preferences.

[4] A= priority 1; B=priority 2; C=priority 3; and D=priority 4.

Content Style	Average	Synthesis	Std. Dev.
a) Information richness	***27,53***	***A***	***14,40***
b) Information simplicity	***27,22***	***A***	***13,56***
c) Information detailing	***22,37***	***A***	***12,01***
d) Information scientific level	***22,88***	***A***	***15,81***

Table 3. Priorities for content non-functional requirements.

Following non-functional requirements concern presentation aspect of the site-to-be:

Graphics	Average	Synthesis	Std. Dev.
a) Rich and high-impact graphics	***43,33***	***B***	***30,71***
b) Simple and Plain Graphics	***56,67***	***A***	***31,76***

Table 4. Priorities for graphic (presentation) requirements.

With regards to the target audience of the portal, stakeholders were asked to express their priorities for specific characteristics (later called *persons* in AWARE) of the potential users to address. As example, we report hereby the responses for the following characteristics Nationality, Cultural Level and Profession.

Nationality	Average	Synthesis	Std. Dev.
a) Italian	***37,45***	***A***	***12,01***
b) Other European countries	***33,76***	***A***	***8,14***
c) Non european	***28,79***	***A***	***9,30***
Cultural level	**Average**	**Synthesis**	**Std. Dev.**
a) High	***33,28***	***B***	***25,02***
b) Medium	***50,68***	***A***	***24,68***
c) Low	***16,04***	***C***	***13,83***
Profession	**Average**	**Synthesis**	**Std. Dev.**
a) Personnel of the Ministry (and its various ramifications)	***29,27***	***A***	***12,30***
b) Cultural operators in the peripheral administrations.	***34,53***	***A***	***12,06***
c) Cultural mediator (e.g. tourist operators)	***36,20***	***A***	***20,18***

Table 5. Priorities for user characteristics (user persons).

Stakeholders were also asked to express their opinions about addressing specific motivations of use for the target audience (later called *Roles* in AWARE).

Motivations of the users	**Average**	**Synthesis**	**Std. Dev.**
a) Work	***22,58***	***A***	***8,40***
b) Study and Education	***23,03***	***A***	***8,10***
c) Scientific Research	***15,00***	***B***	***8,66***
d) Tourism	***24,39***	***A***	***12,42***
e) Curiosity	***12,27***	***B***	***6,51***
f) Other:	***2,73***	***D***	***7,61***

Table 6. Priorities for motivation of use (user roles).

With regards to more specific content requirements, stakeholders expressed their preferences about the kinds of information objects to favour for the portal.

Content Object	**Average**	**Synthesis**	**Std. Dev.**
a) Figurative Arts	***20,46***	***A***	***9,32***
b) Archeology	***20,19***	***A***	***7,84***
c) Theaters and Movies	***15,06***	***B***	***7,67***
d) Popular traditions	***13,35***	***B***	***7,45***
e) Events (exhibitions, festival)	***20,94***	***A***	***9,70***
f) other:	***10,00***	***C***	***22,03***

Stakeholders were also asked to prioritize categories of decision makers who may be in charge of various tasks. In this example, we report the priorities expressed for the decision makers responsible for the services offered by the portal.

Who should decide the functionality of the portal	**Average**	**Synthesis**	**Std. Dev.**
a) Ministry responsible	***17,59***	***A***	***12,19***
b) Regional representatives of the Ministry	***14,68***	***A***	***8,31***
c) Museums	***14,71***	***A***	***7,78***
d) Local administrations	***12,59***	***A***	***6,73***
e) Managers of cultural events	***12,28***	***A***	***8,19***

f) Universities and researchers	***12,65***	***A***	***7,81***
g) Cultural mediator (publishers and tourist operators)	***12,92***	***A***	***12,91***
h) Other:	***2,58***	***D***	***6,22***

On the basis of the results of the exploratory study, high-level objectives were refined and into content and access requirements; key user scenarios and the design of the core information architecture were elaborated (for details see in [HOC, 2002].

The basic AWARE concepts were employed; however, a textual – although structured - description the results of the requirements analysis was favoured on a graph-based notation.

3.3 Lessons Learned

Goal reasoning makes stakeholders more involved in the project

In case of projects with many stakeholders, goal-based requirements elicitation and analysis is effective not only for gathering goals and viewpoints, but also for making stakeholders more involved and aware about the project.

Goals are a proper level of abstraction for large projects

In case of large projects, making stakeholders focus on goals rather than on the solutions is essential to obtain consensus, and continuously reopen the spectrum of strategic alternatives.

Priorities help drive consensus among stakeholders

Goal priorities, requirements priorities and user priorities may be determined by aggregating the results of interviews and surveys carried out with a variety of different stakeholders.

The role of content requirements

High-level content requirements can help organize the requirements into subsites, each to be considered with its own target goals, audience, scenarios, and specific requirements.

The role of goal graphs

Goal graphs are the only option for documenting goal-driven requirements. Morever, they may be not enough for documenting all the goals, requirements and scenarios. They may be useful to summarize the results *in-the-large* and highlight the key elements.

4 Discovering Goals from Design

4.1 Project Background

In December 2002, AWARE was employed for the reverse requirements engineering project for an advertising agency website. The challenge was trying to understand the reasons behind the design decisions of the current agency web site, and tracing back those requirements to the high-level goals of the stakeholders. The initial objective of the project was "mining" goals and expectations of all the relevant stakeholders (users and customers) so as they may be inferred by the current website design, in order to define guidelines and requirements for possible improvements.

The project was carried out by a 4th year student of the Faculty of Communication Sciences at the University of Lugano, under the supervision of one researcher at TEC lab, the Technology Enhanced Communication Laboratory of the University of Lugano.

As a first step, the student conducted interviews, focus groups and collaborative walkthroughs on the site together with agency representatives. Then, after a basic training about the AWARE model based on the documentation of the experience of previous case studies, the student tried to apply AWARE following two lines of reasoning:

a) identifying stakeholders, goals and requirements of the actual site from the material gathered during the interviews and focus groups;
b) wondering "Why is it there" and "Whom is it useful" for each relevant design element (content, navigation structure, service or functionality offered) of the site.
c) Structuring and analyzing the gathered material by means of goal graphs using the AWARE notation;
d) Validating the goals and the requirements with agency representatives and one researcher at TEC lab.

This work represents a special case of *goal-mining* [Antón, 1997] so as it is applied to web site design elements. The result of this activity is the definition of high-level stakeholders goals driving the design, and traceability links between the goals and the actual site requirements.

Requirements were then classified according to the AWARE hypermedia taxonomy, to assess the degree of coverage of the main design aspects provided by the analysis. Text descriptions of the results of the goal-mining are accompanied by AWARE goal-graphs[5], which are partly illustrated in the next paragraph.

FACT SHEET Goal-mining advertising agency	
Artefacts Produced	
# Stakeholders Identified	5
# High-level goals	15
# Subgoals	20
# Hypermedia Requirements	22
Effort Spent	
# Analysts	1
# men/day	5
Tools Used	
% AWARE features exploited	90%
Editing, CASE tools	MS Word

4.2 Excerpts from Analysis Artefacts

Some of the main target users identified for the agency web site are a potential client of the agency ("nuova azienda"), and a collaborator of the agency. High-level goals, at different level of granularity, have been defined for each user profile.

Whereas the potential new client has open and ill-defined goals, such as "get and idea of the agency", or "know the approach to the customer", the collaborator needs to be supported in more operative tasks, such as "check the news", "find specialized personnel for a given project", or "browse the archive of past works".

[5] We present the *original* artefacts of the analysis, that were written in Italian.

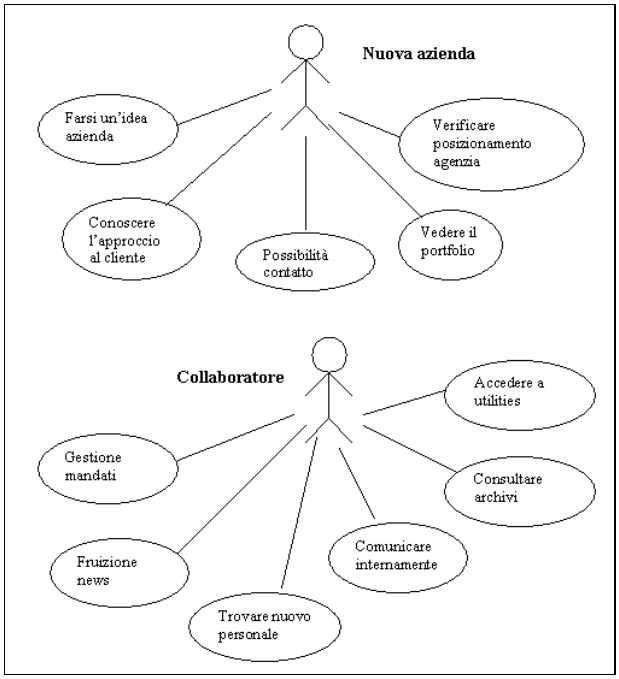


Figure 16. High-level goals for two main user profiles.

The agency, on the other hand, has its own communication objectives to accomplish by means of the site. The agency wants to increase its reputation, provide an easy way to be contacted by customers, and inform the customers about the current activities.

Even if it is a simple example, it is interesting to note that in the first version of the analysis, the goals of the agency were not documented. The student considered the perspective of the user only, omitting to adopt the perspective of the agency itself, who represents the main stakeholder who conceived and built the website.

This is a sign of the fact that it is not given for granted that requirements analysis and design are stakeholder-centered. Often, analysis is solely user-centered, forgetting to consider the communication goals of the client and the main stakeholders that should have an actual impact on the design decision.

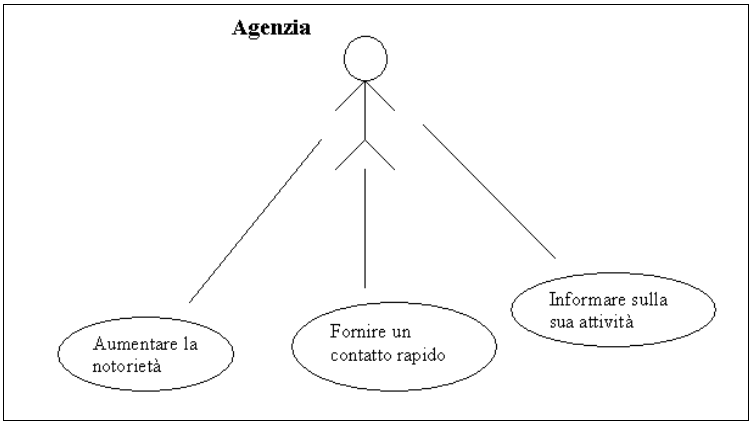


Figure 17. Main goals of the advertisement agency.

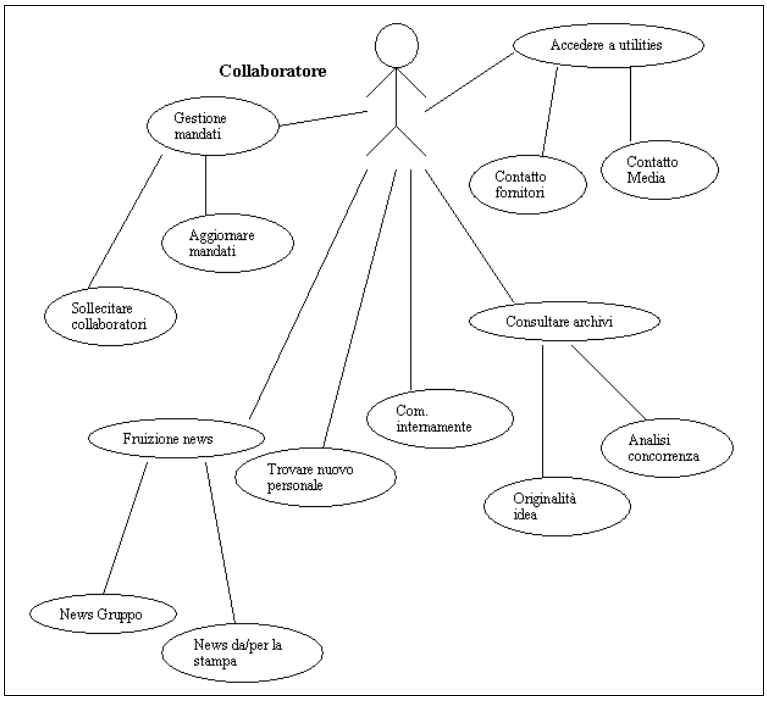


Figure 18. Goal Refinement for Collaborator goals.

Another problem encountered during analysis was the assignment of correct design dimension to the requirements. As portrayed in the refinement of the goal "manage assignments" ("gestione mandati") in Figure 19, some requirements labeled as presentation requirements were actually concerning the content. Other requirements labelled as navigational were instead content requirements as well. User and system

operation requirements (respectively labeled as “U” and “O”) were correctly identified and distinguished more clearly from other hypermedia aspects.

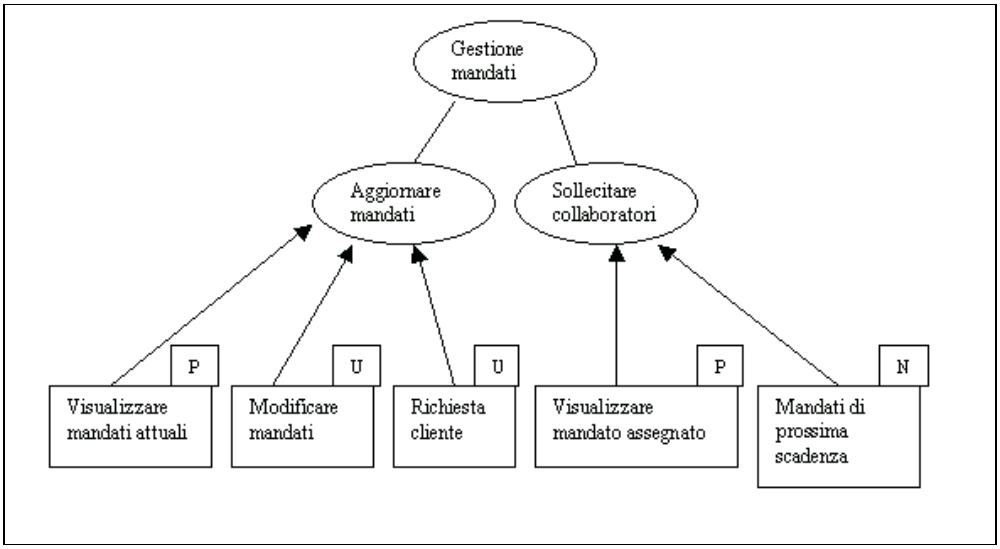


Figure 19. Identification of the requirements for the goal “Managing Assignment”.

These errors in identifying the proper requirements concern may be due to a number of factors. Probably, the AWARE documentation available when the project was carried out, was not effective in communicating the distinctive features of each type of requirements. It is also possible that the training effort dedicated to the requirements taxonomy was not enough to teach properly the detailed hypermedia classification of requirements.

It is true, though, that the way a requirement is stated may be ambiguous as to the design dimension concerned, right because hypermedia aspects (content, navigation, access, and presentation) are always tightly intertwined and difficult to separate.

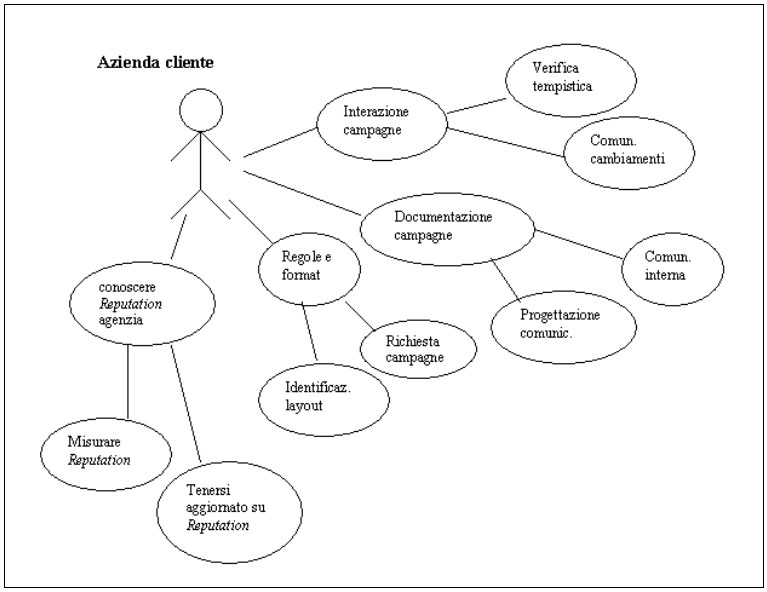


Figure 20. Refinement of the goals of the potential client of the agency.

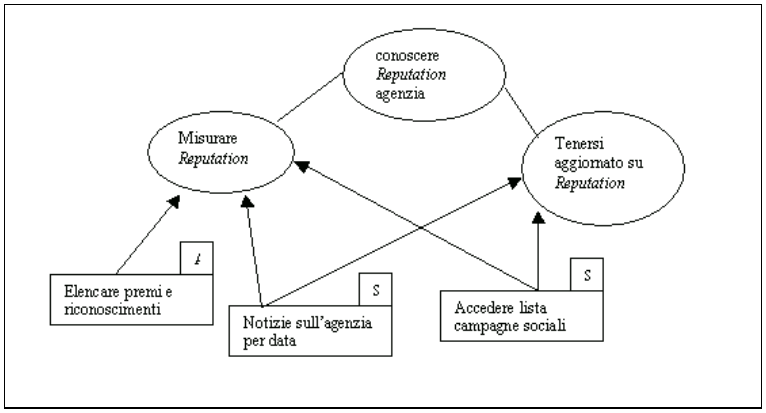


Figure 21. Identification of requirements for the goal "know the reputation of the agency".

4.3 Lessons Learned

Goal-mining may be used for redesign

The use of AWARE increased stakeholders understanding of the current application and helped them to get a clearer picture of all the factors composing the communication strategy currently adopted by the site. The work paves the way for understanding missing goals, not properly refined goals, envisioning alternative design strategies and

identifying new potential users. Eventually, new requirements may be defined for improving the site design.

It is difficult to express requirements at the proper conceptual level

It was problematic to express the requirements at the proper level of abstraction. It was acknowledged that the domain expertise mastered by the students helped him to capture the requirements. However, it was difficult to define requirements in such a way that they did not trespass to detailed features seen on the site (such as implementation solutions or graphic features).

It is difficult to assign design dimensions to requirements

The requirement dimension assigned to each requirement was often inaccurate. Heuristics and golden rules for identifying the proper requirement dimension and defining requirements at the proper level of abstraction would be helpful tools to integrate in the model.

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Annex III

AWARE Glossary

Abstract

AWARE is a stakeholder-centered requirements analysis toolset that may be used by analysts and designers to conceive goal-oriented web applications.

This document lists the main concepts of the AWARE model and gives a brief definition for each term. The scope of the glossary is to provide analysts, designers, and also students, scholars, and researchers a quick access to the explanation of the AWARE vocabulary.

The meaning of the terms hereby reported is intended to be restricted to their application to web requirements analysis and, in particular, to the AWARE requirements analysis model. Therefore, the description of the entries may not capture the significance the terms may assume in other contexts, in other models, or in other stages of the development cycle. In other words, they are not absolute statements, but definitions valid in the context of the AWARE framework. Other concept definitions are instead borrowed, and therefore widely applicable to a variety of fields, such as hypermedia design, human-computer interaction, communication design and requirements engineering.

Application Scope:

the degree of granularity by which a user goal designates a portion of the web application domain. For example, the goal `Check the price of product type X` price has a narrower application scope than the goal `Check the assortment of products`.

Access Requirement:

a requirement concerning the paths available to the user in order to locate and reach and the needed content, or the strategies for leading/guiding the user to the content. An example of access requirement may be `Organize the product families by brand`.

Communication-intensive websites:

web applications mainly conceived by stakeholders who need to achieve communication goals, i.e. who wish to use the site to get across messages and establish a dialogue with a variety of users. Communication-intensive aspects may coexist with transaction-oriented aspects, typical of traditional information systems. E-commerce web sites are typical examples of this combination. Other examples of communication-intensive websites include cultural-heritage web sites, educational web sites, institutional web sites, promotional and corporate web applications.

Content Requirement:

a requirement concerning the kind of information and messages that need to be communicated to the user. An example of access requirement may be `Provide product buying information.`

Design Dimension:

a design concern mainly impacted by a requirement. Hypermedia design dimensions include `content`, `structure of content`, `navigation`, `access to content`, `user operation`, `system operations`, and `interaction`.

Goal:

a high-level target of achievement for one or more site stakeholders. An example of client goal is `Build and maintain trust in the customer.` An example of user goal is `Buy an original gift for Christmas`. The granularity of user goals may vary along two dimensions: application scope and user scope.

Hypermedia Requirement Taxonomy:

a set of design dimensions to be assigned to requirements, concerning the hypermedia aspects of a web application. Hypermedia design dimensions include `content`, `structure of content`, `navigation`, `access to content`, `user operation`, `system operations`, and `interaction`.

Interaction Requirement:

a requirement concerning unusual and advanced styles of interaction of the user with the website. In a museum of modern art, an interaction requirement could be to `provide the user with an interactive 3D model of a representative work of art`, to raise her interest in understanding the modern art.

Navigation Requirement:

a requirement that suggests connections between different information pieces semantically related, thus allowing the user to navigate from one piece of content to another. Examples of navigation requirements are: `relate each painter to its author`, `relate visits information to restaurant and hotel services available`, `relate history collection to most precious work of arts`.

Presentation Requirement:

a requirement concerning the visual communication strategies for presenting content, navigational capabilities and operations to the user. Examples of

presentation requirements might be: `present a young style for teenagers in the Kids section`, or `present a professional and artistically rich style in the collection layout`.

Priority:

the importance of an artifact defined during the requirements analysis. AWARE distinguishes between:

- ***Stakeholder priority****:* the importance of a stakeholder;
- ***Goal Priority***: the importance of a goal;
- ***Stake priority****:* the importance of a goal for a stakeholder;

Priority values can also be propagated to requirements, subgoals and refinement links.

Refinement process:

an iterative decision-making process consisting in a step-by-step elaboration and decomposition of high-level goals into subgoals, and eventually into requirements satisfying the upper goals. The refinement is carried out taking into account the constraints and the resources of the project.

Requirement:

a description of a desired characteristic of the website relevant for one or more stakeholders and representing an appropriate input for the design activity.

Requirements Analysis:

the activity of defining a consistent set of requirements for the website-to-be that might satisfy as much as possible all the main goals of the stakeholders.

Scenario:

a narrative, task-oriented description of an episode of use of the website. AWARE distinguishes between:

- ***User Scenario:***a description of an envisioned and plausible episode of use of the website focusing on what a potential user might want to do on the website;
- ***Client Scenario***: a description of an envisioned and plausible episode of use of the website focusing on what a client or a main stakeholder wants the user to do on the website.

Softgoal:

a goal without a clear-cut criterion for its satisfaction. Unlike functional goals, softgoals may model qualitative achievements (e.g. `Provide reliable transactions`), open-ended expectations (e.g. `Expect accurate content`), or ill-defined goals (e.g. `Being helped in deciding what to buy`).

Stakeholder:

anyone who has an interest in the success of the website, and may share knowledge and information about the application and its domain. Stakeholders are classified in site users and main stakeholders. Main stakeholders include clients, representatives, decision makers, opinion makers, domain experts, and members of the development team.

Structure of Content Requirement:

a requirement giving coarse-grain insights about how the content pieces might be organized. An example is: `Within the product description, highlight the buying information`.

System Operation Requirement:

a requirement describing a functionality performed by the system. Examples may be: `Require user to authenticate`, `Track usage patterns`, or `Update user preferences`.

Task:

a description of a user action to be performed on the website. A task may describe *how* a goal is achieved. Example of task are `Browse product information` or `Change site department`. There is no a clear-cut distinction between tasks and goals, since they span in a continuum between the user scope and the application scope.

Usability Evaluation:

the activity by which the quality of the website is measured in terms of its capability to effectively support the achievement of stakeholder goals.

User Composite Profile:

a meaningful combination of a user person and a user role with their relative goals. For example, a user composite profile may be a `first-time visitor` (person) in a `casual visit` (role) that may `get an idea of the products offer`, `check the latest promotions`, and `compare product prices` (goals).

User Operation Requirement:

a requirement describing the functionality provided by an operation visible to the users to complete some tasks. Examples are `Send an e-card to a friend`, `Add an item to the shopping cart`, or `subscribe to a mailing list`.

User Person:

a personal characteristic of a potential user, chosen along any orthogonal aspect that analysts consider relevant for the design. For example for the aspect *site knowledge*, possible persons are `First-time visitor`, `Returning visitor`, `experienced visitor`. For the aspect *profession*, possible persons may be `Student`, `Teacher`, or `Journalist`.

User Role:

the intentional setting of a user approaching the website that clearly expresses a plausible motivation of use. Examples of roles may be: `Casual surfer`, `Event checker`, `Buyer`, or `Info gatherer`.

User Scope:

the degree of transparency and precision by which a user goal circumscribes the user experience. For example, the goal `See whether the conference is worth going` has a much broader user scope than the goal `See accepted papers on theme X`.

Web Conceptual Design:

the activity of conceiving and documenting the overall conceptual and interactional architecture of the website as it will influence the user experience.