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ΣΧΟΛΗ ΘΕΤΙΚΩΝ ΕΠΙΣΤΗΜΩΝ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΥΠΟΛΟΓΙΣΤΩΝ

Η τεχνολογία διαδικτυακών πυλών στην ανάπτυξη, διάχυση και χρήση οδηγιών σχεδίασης

Παρταράκης Ι. Νικόλαος

Μεταπτυχιακή Εργασία

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Πανεπιστήμιο Κρήτης
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Τμήμα Επιστήμης Υπολογιστών

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Εργασία που υποβλήθηκε από τον

Παρταράκης Ι. Νικόλαος

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Στους γονείς μου,
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Περίληψη

Οι *οδηγίες σχεδίασης* (guidelines) και τα *πρότυπα* (standards) αποκτούν ολοένα και μεγαλύτερη σημασία παγκοσμίως. Στην ουσία αποτελούν ένα ταχέως αναπτυσσόμενο μέσο για την μεταφορά *γνώσης* (know-how). Παραδείγματος χάριν, άτομα που ασχολούνται με την σχεδίαση και ανάπτυξη εφαρμογών, ειδικά σε περιπτώσεις όπου χρησιμοποιούνται συνθέτες και προηγμένες τεχνολογίες, αναζητούν οδηγίες σχεδίασης και πρότυπα για να εξασφαλίσουν συνέπεια και την φιλικότητα προς τον χρήστη. Παρόλα αυτά, οι διαδικασίες ανάπτυξης τέτοιου είδους γνώσης-πληροφορίας, καθώς και τα μέσα για την κατάλληλη διάχυση και χρήση αυτής, βρίσκονται ακόμα σε εμβρυακή φάση. Για παράδειγμα, διάφορες έρευνες που πραγματοποιήθηκαν, για να αξιολογήσουν την χρήση οδηγιών σχεδίασης και προτύπων από άτομα που συμμετέχουν στην ανάπτυξη και σχεδίαση λογισμικού, κατέδειξαν ότι γνώση αυτού του είδους συχνά αγνοείται παντελώς.

Η παρούσα εργασία προτείνει μία νέα προσέγγιση, βασισμένη σε τεχνολογίες *διαδικτυακών πυλών* (portals), για την ανάπτυξη, διάχυση και χρήση οδηγιών σχεδίασης, συμπεριλαμβανομένου προτύπων. Πιο συγκεκριμένα, η προτεινόμενη προσέγγιση αφορά την σύσταση μίας γενικής διαδικασίας για την ανάπτυξη, χρήση και μετέπειτα συντήρηση οδηγιών σχεδίασης και προτύπων, σε διάφορα πεδία εφαρμογής λαμβάνοντας υπόψη της την συσσωρεμένη εμπειρία ατόμων που εργάζονται στην ανάπτυξη εφαρμογών λογισμικού, εκπροσώπων της αγοράς προϊόντων λογισμικού, και ειδικών σε ζητήματα προτυποποίησης και σύνθεσης οδηγιών. Επιπροσθέτως, παρουσιάζεται ο τρόπος αξιοποίησης της τεχνολογίας διαδικτυακών πυλών για την υλοποίηση (μηχανογράφηση) της προτεινόμενης διαδικασίας.

Τέλος αναλύεται η μεθοδολογία που ακολουθήθηκε για την σχεδίαση και ανάπτυξη πρότυπης πύλης για οδηγίες και πρότυπα που εστιάζουν σε εφαρμογές *εικονικής πραγματικότητας* (virtual reality), ώστε να μπορεί να λειτουργήσει πιλοτικά ως ένα προηγμένο διαδικτυακό περιβάλλον που επιτρέπει (α) τη ομαδική ανάπτυξη οδηγιών σχεδίασης και προτύπων, μέσω ειδικής περιοχή της πύλης που απευθύνεται στα άτομα που συμβάλλουν στην ανάπτυξη γνώσης, και (β) την πρόσβαση σε οδηγίες σχεδίασης και πρότυπα, μέσω ειδικής περιοχής της πύλης που απευθύνεται σε άτομα που αναζητούν σχετική γνώση.

Η υλοποίηση και πιλοτική χρήση της πρότυπης πύλης για οδηγίες σχεδίασης εφαρμογών εικονικής πραγματικότητας επιβεβαίωσε την αρχική μας υπόθεση ότι η ορθή αξιοποίηση της τεχνολογίας διαδικτυακών πυλών μπορεί να πλαισιώσει και υποστηρίξει κατάλληλα συλλογικές προσπάθειες ανάπτυξη οδηγιών και προτύπων. Ταυτόχρονα μπορεί να καταστήσει δυνατή την αποτελεσματική διάχυση και χρήση της παραχθείσας γνώσης, και λειτουργώντας ως κόμβος επικοινωνίας μεταξύ έρευνας και αγοράς να συμβάλλει δραστικά στην εξάλειψη του χάσματος μεταξύ ζήτησης και προσφοράς.

A portal-based tool for developing, delivering and working with guidelines

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Abstract

Guidelines and standards are gaining increasing importance worldwide, as they constitute a rapidly evolving medium for transferring established know-how and de facto knowledge to various interested parties. For instance, designers and developers, in various application domains, employ guidelines and standards in order to achieve consistency and user-friendliness of user-interfaces, especially in cases where complex and state-of-the-art technologies are employed. However, the process of developing such knowledge and the means for its appropriate dissemination and utilisation are still in a state of flux. For instance, several studies investigating the use of guidelines and standards by designers and developers have concluded that they are, for a number of reasons, frequently ignored.

This thesis proposes a novel, portal-based approach for the development, dissemination and use of guidelines and standards. More specifically, the proposed approach concerns the establishment of a generic process for the development, use and subsequent maintenance of guidelines-related knowledge in various application domains taking into account the accumulated experience of people working on the development of IT products, representatives of the target market of these products and experts on guidance and standardisation. Furthermore, the appropriate exploitation of portals technology for the effective and efficient utilisation of the process is presented, analysing the employed methodology towards the design and development of a prototype portal structure to serve as an advanced, web-based environment for enabling (a) the cooperative development of guidelines and standards - at the knowledge developers' site, and (b) the practical communication and use of guidelines and standards - at the knowledge consumers' site. The practical exploitation of the concept in the form of a pilot portal for guidelines for

Virtual Reality applications confirmed the hypothesis that the appropriate utilisation of portals technology can (a) provide the means for developing guidelines and standards building on a well defined process, (b) facilitate the efficient communication and use of the knowledge developed, and (c) ultimately serve as a bridge among knowledge developers and consumers and thereby contribute to the elimination of the demand - supply gap.

Executive Summary

The evolutionary progress in computer science has led to the penetration of computers in most aspects of our everyday lives. In the emerging Information Society, computers are used, not just by experts but, potentially by everyone. One of the most important goals of computer science in this context is to make the ways that people interact with technology and information more efficient, especially in emerging and promising IT fields. In these fields where research and development are still in a state of flux, several limitations arise, such as hardware software interoperability, cross platform compatibility, accessibility and usability, health and safety, and security issues.

A well-discussed solution to such limitations is the provision of appropriate guidelines and standards that can be employed in various steps of the development life cycle of IT applications. In fact, guidelines and standards are gaining increasing importance worldwide. In essence, they constitute a rapidly evolving medium for transferring established and de facto knowledge to various interested parties. However, despite the indisputable value and importance of such knowledge, several studies investigating the use of guidelines and standards by designers and developers have concluded that they are frequently ignored. Current efforts to avoid the underutilisation and wasteful regeneration of guidelines and standards have given rise to a new generation of tools, which are usually referred to as Tools for Working with Guidelines (TFWWGs). TFWWGs are interactive software applications or services that offer support for the use and integration of guidelines-related knowledge at any stage of an IT product development life-cycle.

This thesis is motivated from the perspective that TFWWGs should provide a collaborative, extensible and evolutionary medium, offering more than mere access to ergonomic knowledge. Nonetheless, previous efforts made towards the development of such tools have focused mainly on the effective and efficient delivery of such knowledge, paying limited, if none at all, attention to the actual knowledge development process. To this effect, this thesis provides a novel approach for the development and use of guidelines and standards. This is achieved with the establishment of a generic process for

the development, use and subsequent maintenance of guidelines and standards taking into account the accumulated experience of all potential stakeholders, such as people working on the development of IT applications, representatives of the target market of IT products and experts on guidance and standardisation. Furthermore, prototype system developed in the context of this work builds on the aforementioned process and provides an advanced web based environment for enabling (a) the cooperative development of guidelines and standards - at the knowledge developers' site, and (b) the practical use of guidelines and standards – at the knowledge consumers' site. The practical exploitation of the concept has been in the form of a pilot portal for guidelines for Virtual Reality applications, namely *Pages for VR*.

The most prominent characteristics of Pages for VR regarding the provision of support for the design, development and evaluation of VR applications include:

(i) alternative ways for knowledge retrieval,
(ii) mechanisms for maintaining personal collections of knowledge,
(iii) user profiling for improved results filtering,
(iv) user interaction history facilities, and
(v) knowledge administration services.

At last, but not least, Pages for VR extends the scope of previous attempts to provide tools for working with guidelines by offering significant support for the (collaborative) development of guidelines and standards. This is mainly achieved by the provision of a collaborative development environment that facilitates all the steps potentially involved. More specifically Pages for VR provides:

(i) facilities for creating and running special interest working groups in order to organise and manage into thematic areas all the development activities,
(ii) services for each different user role participating in the process,
(iii) brainstorming sessions for generating new ideas for guidelines and standards,
(iv) interfaces for the collaborative development of proposals and projects, and
(v) user and project administration facilities.

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Abbreviations and acronyms

BoE	Abbreviation for *Board of Executives*
CD	Abbreviation for *Consensus Draft* of a CDGS Report
CDGS	Abbreviation for the process for *Collaborative Development of Guidelines and Standards*
CRGS	Abbreviation for *Collaborative Revision of Guidelines and Standards*
CVE(s)	Abbreviation for *Collaborative Virtual Environment(s)*
FORTH-ICS	Acronym of the *Foundation for Research and Technology – Hellas, Institute of Computer Science*
ISO	Acronym of the *International Organisation for Standardisation* (see www.iso.org)
NWP(s)	Abbreviation for *New Work Proposal(s)*
WG(s)	Abbreviation for *Working Group* (s)
WGL(s)	Abbreviation for *Working Group Leader(s)*
WGM(s)	Abbreviation for *Working Group Member(s)*
TFWWG(s)	Abbreviation for *Tool(s) For Working With Guidelines*
RCD	Abbreviation for the *Revised Consensus Draft* version of a GDGS Report
VE(s)	Abbreviation for *Virtual Environment(s)*
VIEW or **View of the Future**	Acronym of the IST project *Virtual and Interactive Environments for Workplaces* ***of the Future*** *(Contract no.: IST-2000-26089)*
INTUITION	Acronym of the *IST Network of Excellence on VIrtual Reality aNb VirTUal Environments ApplIcaTIONs for*

	Future Workspaces (Contract no.: 507248-2)
VR	Abbreviation for *Virtual Reality*
WD	Abbreviation for ***W****orking* ***D****raft* of a CDGS Report
WSSN	Acronym for the ***W****orld* ***S****tandards* ***S****ervices* ***N****etwork* (see http://www.wssn.net)
HCI	Abbreviation for *Human Computer Interaction*
ExE(s)	Abbreviation for ***E****xternal* ***E****xpert(s)*
IP(s)	Abbreviation for ***I****nterested* ***P****arties*
FP(s)	Abbreviation for ***F****ocal* ***P****oints*
GSE(s)	Abbreviation for ***G****uidelines* ***&*** ***S****tandardisation* ***E****xperts*
SIG	Abbreviation for ***S****pecial* ***I****nterest* ***G****roup*
NMC	Abbreviation for ***N****etwork* ***M****anagement* ***C****ommittee*

1. Introduction

1.1 Increasing need for guidelines

Nowadays, guidelines and standards play a key role in the adoption of (computer) technologies by industries and society. In essence, they constitute a rapidly evolving medium for transferring established and de facto knowledge (know-how) to various interested parties. For instance, designers and developers, in various application domains, require guidelines and standards in order to achieve consistency and user-friendliness of user-interfaces, especially in cases where complex and rapidly evolving technologies are employed.

1.2 Issues involved in the lifecycle of guidelines

Despite the increasing need and the indisputable value and importance of such knowledge, several studies investigating the use of guidelines and standards by designers and developers (e.g., Wandke & Hüttner, 2001) have concluded that they are frequently ignored. This problem is mainly resulted by existing limitations in the process of developing, communicating and using ergonomic knowledge. First, guidelines are today developed as general or platform specific rules, by organisations as part of internal processes, no specialised IT tools available. Second, guidelines are often difficult to communicate to developers. Such knowledge is not easily exploitable (Tetzlaff & Schwartz, 1991), and their incarnation medium (i.e., paper based-manuals) raises issues of ineffectiveness and lack of user-friendliness (e.g., Bevan & Macleod, 1994). Thirdly, guidelines are often difficult to use. In particular, recommendations derived from guidelines are not always comprehensible or easily appropriated by the development team. Furthermore design recommendations derived through different sets of guidelines (or within the same set) are often conflicting. In other words, one guideline may invalidate another guideline. At the same time, guideline documents, or reference manuals, offer no natural way of resolving ambiguities and does not include additional material such as references, best practice examples and illustrations for the available design guidance, which typically leads to arbitrary decisions by the designer, or the design team.

1.3 Recent approaches

The issues involved in the lifecycle of guidelines and the limitations that arise, in combination with the emerging need for interactive tools to support development activities, have given rise to a new generation of tools, which are usually referred to as Tools for Working with Guidelines (TFWWGs). TFWWG are interactive software applications or services that offer support for the use and integration of guidelines-related knowledge at any stage of an IT product development life-cycle. In this direction, preliminary efforts were targeted to the integration of guidelines into hypertext-based tools, which allow software designers to access design guidelines organised either as a database or hypertext (e.g., Perlman, 1987; Vanderdonckt, 1995) or using a digital library that facilitates design time assistance, such as i-dove (Karampelas et al., 2003). Furthermore, TFWWGs such as Sherlock (Grammenos, Akoumianakis & Stephanidis, 2000) were designed to assist the user interface usability inspection process and therefore provide active support to various phases of the development process. Nonetheless, R&D efforts in the field of TFWWGs have mainly focused on the effective and efficient delivery of such knowledge to potentially interested parties, paying limited attention to the process of its development.

1.4 A portal-based approach

Portals technologies can potentially be employed in order to overcome the limitations that arise by the way that guidelines are developed, communicated and used. First, regarding the development of such knowledge portals can be employed to facilitate the collaborative development of such knowledge by multidisciplinary teams, building on a well defined and sound process taking into account the accumulated experience of the target user population. Second, portals can contribute towards avoiding under-utilisation and regeneration of existing knowledge, bridging the gap between knowledge developers and knowledge consumers. This can be achieved by the incorporation of technologies such as digital libraries that can boost the way that such knowledge is communicated raising the awareness of the target user population. Thirdly, portals can provide advanced communication and retrieval mechanisms providing in that way guidance for the tasks of finding knowledge by means of social navigation or by traditional browsing and searching techniques and using such knowledge through the provision of reference material such as examples and codes of good practices.

Under the light of the above, this thesis proposes a novel approach for the development and use of guidelines and standards. More specifically, the proposed approach concerns the establishment of an appropriate portal structure to serve as an advanced, web-based environment for enabling (a) the cooperative development of guidelines and standards - at the knowledge developers' site, and (b) the practical use of guidelines and standards - at the knowledge consumers' site.

Overall, depending on the needs and constraints (market, time, etc.), there is a number of available guidelines and standards-type document than can be produced and exploited by means of the proposed portal structure, including:

- (i) (recommendations for) standards,
- (ii) design/development/use guides,
- (iii) technical reports and specifications, and
- (iv) collections of guidelines.

As a pilot test, the solution proposed in this work for facilitating the development, communication and use of ergonomic knowledge has been applied in the Virtual Reality domain, an evolving field of research were the need for design guidelines is of fundamental importance and the efforts towards the development of ergonomic knowledge are not yet mature.

1.5 Structure of this report

This thesis is organised as follows:

- Chapter 2 introduces the reader to the basics of guidelines and standards, and highlights benefits and issues in their use at organisational, national and European levels. Additional it discusses the limitations of guidelines and standards that often result to the underutilisation of such knowledge. To this end, the proposed solutions from the international literature for overcoming these limitations are also presented here, such as TFWWGs and other potential technology-based solutions, such as tools supporting virtual collaboration and knowledge organisation.
- Chapter 3 presents the objectives of this research work and analyses its context and scope. The *Pages for VR* tool, as a first incarnation of our approach, is then introduced highlighting its importance for achieving standardisation in the field of VR and therefore overcoming fragmentation. Furthermore a preliminary discussion is conducted regarding the target user population of the system and the main considerations for achieving the efficiency of the final system in terms of utility, usability and accessibility.
- Chapter 4 describes the process proposed (and computerised in the form of the *Pages for VR* prototype tool) for reviewing, updating and extending guidelines and standards in a collaborative manner focussing on user roles, the process variations according to required level of strictness and finally the potential outcomes of the process.
- Chapter 5 provides a detailed overview of the preliminary design steps of the interactive prototype, justifying the adopted design decisions and presenting the iterative phases followed. More specifically the phases described are the user requirements analysis, tasks analyses and the user interface design.
- Chapter 6 provides an overview of the knowledge base of the system in terms of organisation and categorisation of knowledge. Additionally the various resource types incorporated and the metadata used for their presentation are presented. Furthermore a detailed description of the tool is provided taking into account all

the stakeholders participating in the process of reviewing, updating and extending guidelines and standards.

- Chapter 7 presents the software architecture followed for the development of the system's infrastructure and highlights the technical characteristics of the final system.
- Chapter 8 discusses the original objectives set by this research work and the extent to which these objectives were achieved analysing in parallel the main challenges faced and the potential drawbacks of the implemented solutions.
- Chapter 9 provides a summary of the processes followed for the design and development of the prototype and highlights the potential techniques that could be applied in the context of future amendments for improving the effectiveness and efficiency of the system.

2. Background and Related Work

2.1 Introduction to guidelines

2.1.1 Definition of "Guideline"

The term "guideline", in the present context, entails all forms of abstract or concrete recommendations that can be used to design interactive software. Guidelines can be expressed as general and domain independent recommendations (Smith and Mossier, 1986) or platform-specific style guides (Open Software Foundation, 1993; Microsoft, 1995; Apple Computers, 1992; IBM, 1992) or experience-based usability heuristics (Henninger et al., 1995; Henninger et al., 1997). Guidelines can be embedded in reference manuals and standards, or can be part of the corporate culture and practice of an organisation (i.e., customised corporate design wisdom).

The following definition of guideline is adopted in the context of this thesis: "*any design and/or evaluation principle to be observed in order to get and/or guarantee the usability of a user interface (UI) for a given interactive task to be carried out by a given user population in a given context*" (Vanderdonckt, 1999).

2.1.2 Sources and types of Guidelines

In general, sources of existing guidelines for conventional computer systems and applications fall into five categories (Bastien & Scapin, 1995; Vanderdonckt, 1999):

(a) **Design rules**: they usually consist of a set of functional and operational specifications that clarify the design of a particular user interface. These specifications are presented in a form that should not require any further interpretation, either from designers or from developers. Their straightforward format allows an immediate exploitation.

(b) **Ergonomic algorithms**: such algorithms typically aggregate single design rules into a comprehensive and systematic procedure that can be applied more quickly than a series of single guidelines. In this way, ergonomic algorithms introduce more flexibility by enabling designers to select parameters required for design rules, and prevent designers to inadvertently forget some design rules. They usually appear as a software component that implements an algorithm, rather than a paper procedure.

(c) **Style guides**: they comprise a set of guidelines and/or functional or non-functional specifications aiming at consistency for a collection of distinct user interfaces. This collection can be based on an operating system, a software editor, a particular physical environment, a domain of human activity or even on a corporate strategy.

(d) **Compilations of guidelines**: they comprise several prescriptions written for a wide range of user interfaces. Each prescription is presented as a statement, sometimes along with examples, with or without clarifying explanations and comments. Each prescription generally results from a consensus among guideline users. Consensus is less relevant once a prescription is experimentally tested and verified. The scope of the compilations can range from a small set of guidelines dedicated to a particular usability feature (e.g., an interaction technique), to an extensive collection of guidelines covering a family of tasks and domains. Some guidelines are validated by experimental results provided by user testing, laboratory experiences or other techniques, while others are not.

(e) **Standards**: they comprise a set of functional and/or operational specifications intended to standardise design. Standards are promulgated by national or international organisations for standardisation. They can be military, governmental, civil or industrial (*standards are defined and presented more analytically in section 2.2.*).

Henninger (2001) adopts a similar classification of the existing design guidance, separating domain specific, for example, web design guidelines, and general purpose guidelines, e.g., principles of menu design. Moreover, he extends the aforementioned classification by adding design patterns as a new form of design guidance. The objective of design patterns, according to Henninger, is to capture recurring design problems along with the respective context of use and to force a direct operation on the problem for yielding a general solution. Another definition for design patterns comes from a software engineering perspective and denotes that a design pattern is a description of a well-tested solution to a recurring problem within the field of software design (Agerbo and Cornils, 1998). The main purpose of the design patterns according to this perspective, adapted however in the user interface design domain, is to distribute the knowledge of good design, so that designers of the user interface can benefit from work previously done within similar areas. It appears from the aforementioned attempts to classify the design guidance that scientists do not yet share a commonly acceptable categorisation. This leads to the underutilisation of the available design guidance, since the same knowledge can be found under different classification in the majority of the design support tools.

2.1.3 The Role of Design Guidelines

Design guidelines can help to provide a framework that can guide designers towards making sound decisions. These guidelines can take a variety of forms and may be obtained from several sources. For example, journal articles, general handbooks and company house style guides are common sources. The important thing to remember about guidelines is that they need to be applied very carefully; they provide guidance - no ‘cookbook’ of HCI exists, nor is such a thing likely to exist.

Guidelines are limited in their use. However they can be useful in helping designers to focus on what is needed and to deal with trade-offs. In this sense the best kinds of guidelines are general principles. In addition it can be useful to provide examples of how the guideline can be used, what the exceptions are and the psychological data the rule derives from.

The role of guidelines is further elaborated below:

(a) ***Raising awareness of concepts:*** A guideline may introduce a concept that has not been encountered before. The following guideline from Microsoft is such an example: “A cascading menu is a submenu attached to the right side of a menu item. It can be added to drop-down menus, contextual menus, or even other cascading menus.” This guideline might be encountered while searching for information of another kind. If we have never experienced cascading menus before, this will be a new concept that we can retain for possible use at a later date.

(b) **Assisting in design choices:** When we need help with a design decision, we may find the answer in a guideline. For example: Suppose we are designing a command-line style of user interaction, and need to allocate the command line itself to a place on screen. Should it be at the top or the bottom? The following guideline is quoted by Mayhew (1992): Locate the command line near the bottom of the screen unless it is clear that the user’s gaze will be elsewhere

(c) ***Offering strategies for solving design problems:*** We can find strategies we need in sets of guidelines. For example, while investigating solutions based on scrolling techniques we might encounter the following guideline: ‘When your application organises data logically into pages, provide page-oriented scroll bars’. The provision of overall design strategies is a common role of the ‘desktop’ style guides written in support of proprietary software systems.

(d) ***Supporting evaluation:*** Heuristic guidelines can support evaluation (e.g., Nielsen, 1994). On a more informal basis, we can use guidelines as usability checklists. For example, when conducting a review of a menu-based interface, we can check it against the guidelines offered by Mayhew, which include the following: ‘Facilitate backwards navigation’

2.2 Guidelines vs. Standards

2.2.1 Definition of “Standard”

The term “standard” refers to a “*document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or* *characteristics for activities or their results, aimed at achievement of the optimum degree of order in a given context*" (ISO/IEC Guide 2:1996, Definition 3.2).

2.2.2 Characteristics of Standards

According to the World Standards Services Network (WSSN)[1], standards:

- **cover several disciplines**: dealing with all technical, economic and social aspects of human activity and covering all basic disciplines such as language, mathematics, physics, etc.;
- **are coherent and consistent**: standards are developed by technical committees which are coordinated by a specialized body, and ensure that barriers between different areas of activity and different trades are overcome;
- **result from participation**: standards reflect the results of joint work involving all competent parties concerned and are validated by consensus to represent all relevant interests: producers, users, laboratories, public authorities, consumers, etc.;
- **are a living process**: standards are based on actual experience and lead to material results in practice (products – both goods and services, test methods, etc.); they establish a compromise between the state of the art and the economic constraints of the time;
- **are up to date**: standards are reviewed periodically or as dictated by circumstance to ensure their currency, and therefore evolve together with technological and social progress;
- **have a reference status**: in commercial contracts and in court in the event of a dispute;
- **have national or international recognition**: standards are documents which are recognized as valid – nationally, regionally or internationally, as appropriate;

[1] World Standards Services Network (WSSN): http://www.wssn.net

- **are available to everyone**: standards may be consulted and purchased without restriction.

As a general rule, standards are not mandatory, but are for voluntary application. In certain cases, implementation may be obligatory (such as in fields connected with safety, electrical installations, in relation to public contracts, etc.).

2.2.3 Level of endorsement of Standards

There are four basic levels of standards, with associated organisations:

(a) **Company** specific standards and procedures

(b) **National** standards, as defined by BSI, AFNOR, DIN, ELOT and so on.

(c) **Regional** standards, as defined by, e.g. CEN, or for aerospace specific standards, as defined by AECMA. In the context of this thesis, regional mostly means European.

(d) **International** standards, as defined by International Standardisation Body (ISO) for example.

According to ISO though[2] the existence of non-harmonised standards for similar technologies in different countries or regions can contribute to the so-called "technical barriers to trade". Export-minded industries have long sensed the need to agree on world standards to help rationalising the international trading process. International standardisation is well established for many technologies in such diverse fields as information processing and communications, packaging, distribution of goods, energy production and so on. It will continue to grow in importance for all sectors of industrial activity for the foreseeable future. The main reasons are given as follows:

(a) World-wide progress in trade liberalisation

(b) Inter-penetration of sectors

(c) World-wide communication systems

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[2] http://www.iso.org/iso/en/comms-markets/conformity/iso+conformity-05.html

(d) Global standards for emerging technologies

(e) Developing countries

2.2.4 The role of Standards

According to ISO, standardisation can be thought as the process of transforming values criteria such as quality, ecology, safety, economy, reliability, compatibility, interoperability, efficiency and effectiveness into real attributes of products and services that are manufactured, delivered, bought, used at work or home, or at play.

In general, standards and standards-type documents aim to support:

- *facilitation of global trade*
- *improvement of quality, safety, security, environmental and consumer protection, as well as the rational use of natural resources*
- *global dissemination of technologies and good practices*

all of which contribute to **economic and social progress**.

A standard represents a level of know-how and technology which renders the presence of industry to its preparation indispensable. A standard is never neutral. It is a reference document used in particular in the context of public contracts or in that of international trade and on which the majority of commercial contracts rely. It is used by industrialists as the indisputable reference, simplifying and clarifying the contractual relations between economic partners. It is also a document that is being used more and more by jurisprudence.

According to WSSN, for the economic players, the standard is:

- **a factor for rationalization of production**: the standard makes it possible to master the technical characteristics, to satisfy the customer, to validate the manufacturing methods, to increase productivity and gives operators and installation technicians a feeling of security;
- **a factor for clarification of transactions**: faced with overabundant product or service offers which may have extremely different practical values, the existence of

systems of reference enables one to better assess the offers and to reduce uncertainties, to aid in the definition of the needs, to optimize supplier relations, to do without additional testing;

- **a factor for innovating and developing products**: to participate in standardisation work enables one to anticipate and therefore to make one's products progress simultaneously. Standards play a favourable role for innovation thanks to transferral of knowledge;
- **a factor for transferral of new technologies**: standardisation facilitates and accelerates the transferral of technologies in fields which are essential for both companies and individuals (new materials, information systems, biotechnology, electronics, computer-integrated manufacturing (CIM), etc.);
- **a factor for strategic choice for companies**: to participate in standardization signifies introducing solutions adapted to the competence of one's company and equipping oneself to compete within competitive economic environments. It signifies acting on standardization, not enduring it. In fact, many companies today are reaching out for global markets, sustainable competitiveness and what is called the "triple bottom line", which addresses three dimensions of company performance – **economic**, **environmental**, and **social**. Therefore, the quality of their technical performance and products has to be matched by environmental performances and governance practices. Standards are proactive to the needs in these dimensions.

2.2.4.1 The economic benefits of Standards

In recent years, technical standardization has been the subject of numerous academic research projects. Although these projects did not ignore economic aspects, they lacked the theoretical background necessary for a detailed analysis. Industry has become increasingly interested in assessing its economic efficiency, and thus is more interested in the role of standardization. Systematic and reliable results can only be attained on a common basis. Because there is greater pressure on industry to rationalize, the costs and benefits of standardization must be examined from both a microeconomic and a macroeconomic viewpoint. The Presidential Board of DIN (Beuth Verlag, 2000) therefore asked research institutes to initiate research into the economic efficiency of standardization, with the aim of making the costs and benefits of standardization transparent from both economic perspectives. DIN, the German Institute for Standardization, contracted the Fraunhofer Institute for Systems and Innovation Research Karlsruhe (ISI Karlsruhe) and the Departments of Market-Oriented Business Management and of Political Economics and Economic Research at the Technical University Dresden to jointly carry out this research project in Germany, Austria and Switzerland.

The final report on "The economic benefits of standardization" presents the conclusions of the research carried out in these three nations, with the following conclusions: As expected, company standards have the greatest positive effect on businesses, for they help improve processes. When it comes to the relationship with suppliers and customers, however, industry-wide standards are the main instruments used to lower transaction costs and assert market power over suppliers and customers. In fact, industry-wide standards play a vital role in our increasingly globalized world. 84% of the companies surveyed use European and International Standards as part of their export strategy, in order to conform to foreign standards. From a macroeconomic perspective, it is significant that standards make a greater contribution to economic growth than patents or licenses that export-oriented sectors of industry make use of standards as a strategy in opening up new markets, and that standards help technological change. That research project showed that industry-wide standards not only have a positive effect on the economy as a whole, but also provide benefits for individual businesses that use them as strategic market instruments.

2.2.4.2 How Standards benefit society

According to ISO[3] standards can be beneficial in a number of ways:

For businesses, the widespread adoption of International Standards means that suppliers can base the development of their products and services on specifications that have wide acceptance in their sectors. This, in turn, means that businesses using International Standards are increasingly free to compete on more markets around the world.

[3] http://www.iso.org/iso/en/aboutiso/introduction/index.html

For customers, the worldwide compatibility of technology which is achieved when products and services are based on International Standards brings them an increasingly wide choice of offers, and they also benefit from the effects of competition among suppliers.

For governments, International Standards provide the technological and scientific bases underpinning health, safety and environmental legislation.

For trade officials negotiating the emergence of regional and global markets, International Standards create "a level playing field" for all competitors on those markets. The existence of divergent national or regional standards can create technical barriers to trade, even when there is political agreement to do away with restrictive import quotas and the like. International Standards are the technical means by which political trade agreements can be put into practice.

For developing countries, International Standards that represent an international consensus on the state of the art constitute an important source of technological know-how. By defining the characteristics that products and services will be expected to meet on export markets, International Standards give developing countries a basis for making the right decisions when investing their scarce resources and thus avoid squandering them.

For consumers, conformity of products and services to International Standards provides assurance about their quality, safety and reliability.

For everyone, International Standards can contribute to the quality of life in general by ensuring that the transport, machinery and tools we use are safe.

(For the planet we inhabit, International Standards on air, water and soil quality, and on emissions of gases and radiation, can contribute to efforts to preserve the environment.)[4]

[4] see http://www.iso.org/iso/en/aboutiso/introduction/index.html - top#top

2.2.5 Types of Standards

According to the same source, four major types of standards can be identified:

- fundamental standards which concern terminology, metrology, conventions, signs and symbols, etc.;
- test methods and analysis standards which measure characteristics;
- standards that define the characteristics of a product (product standard) or of a specification standards which service (service activities standard) and the performance thresholds to be reached (fitness for use, interface and interchangeability, health, safety, environmental protection, standard contracts, documentation accompanying products or services, etc.);
- organization standards which deal with the description of the functions of the company and with their relationships, as well as with the modelling of the activities (quality management and assurance, maintenance, value analysis, logistics, quality management, project or systems management, production management, etc.).

2.2.6 Lifecycle of Standards

According to WSSN, the development lifecycle of a standard generally comprises seven major phases:

- **Identification of the needs of the partners**: analysis per sector of the appropriateness and of the technical-economic feasibility of normative work on the basis of two determining questions: will a standard provide a technical and economic "plus" to the sector? Is the necessary knowledge required for the drawing-up of a standard available?
- **Collective programming**: reflection on the basis of the needs identified and the priorities defined by all of the partners, then decision to register in the work programme of the organization involved;
- **Drawing up of the draft standard** by the interested parties, represented by experts (including producers, distributors, users, consumers, administrations, laboratories, etc. as relevant), gathered together within standardization committees;

- **Consensus** of the experts concerning the draft standard;
- **Validation**: wide consultation, at international and/or national level as appropriate, in the form of a public enquiry, involving all of the economic partners in order to make certain that the draft standard conforms to the general interest and does not give rise to any major objection. Examination of the results and of the comments received. Finalization of the definitive text of the draft standard;
- **Approval** of the text for publication as a standard;
- **Review-Maintenance**[5]: the application of all standards forms the subject of a regular assessment of its relevance by the standardizing body, which makes it possible to detect the time when a standard must be adapted to new needs. Following review, a standard may be confirmed without change, go forward for revision, or be withdrawn.

Most standards require periodic revision. Several factors combine to render a standard out of date: technological evolution, new methods and materials, new quality and safety requirements. To take account of these factors, ISO has established the general rule that all ISO standards should be reviewed at intervals of not more than five years. On occasion, it is necessary to revise a standard earlier. A similar process is followed by ISO[6].

2.3 Limitations of guidelines

Guidelines constitute an inexpensive and widely used tool for communicating human factors knowledge targeted to the creation of more usable and effective UIs; designers and developers require standards or guidelines in order to achieve the consistency and familiarity benefits. However, despite the indisputable value and importance of such guidelines-related knowledge, there are several limitations concerning its usage and exploitation during the design process. Several researchers investigating the use of design

[5] see http://www.iso.org/iso/en/stdsdevelopment/whowhenhow/how.html

[6] see http://www.iso.org/iso/en/stdsdevelopment/whowwhenhow/proc/proc.html

guidance have identified a series of problems that hinder designers and developers from effectively and efficiently exploiting all forms of guidelines. Vanderdonckt has enumerated a list of twenty seven potential problems that may arise during the use of design guidance in the design life-cycle (Vanderdonckt, 1999). The most significant of the identified problems are the huge number of guidelines that increases with time, the physical means of communication of the design guidance, which is usually paper-based, and the variations of guidelines that depend on the context of use. Thus, there are several guideline variations referring to presentation, level of details, complexity, scope, relevant development phase, users, etc., of a user interface. Such guidelines are sometimes in conflict with each other, thus making more complex their application. Moreover, the designer's work is exacerbated by the absence of references, best practice examples and illustrations for the available design guidance. Other researchers focused on the problem of the traditional incarnation of the design guidance (i.e., paper-based manual) that may go unread or misunderstood due to the complex structure of the document or the extensive explanations accompanying the guidance, reducing the applicability of the important points of a guideline (Tetzlaff and Schwartz, 1991; Grammenos et al., 1999). Other studies attributed the problem of the limited application of design guidance to the fact that guidelines usually address specific problems, and are customized for a specific context of use (Parush, 2000), or, on the contrary, are too abstract and simplistic and thus difficult to be interpreted and applied in a specific task. Additionally, the different classification proposed by various scientists hinders the universal reference of design guidance so that knowledge documented as a guideline can be found in another source recorded as recommendation. More recently, other problems have been identified, concerning the rapid evolution of technology that leads to the introduction of new interaction methods and options (Penner and Steinmetz, 2003), new sophisticated devices with non standard characteristics, minimal size, bizarre shape (Sutcliffe, 2000) which in turn impose several restrictions to the application of traditional design guidance in user interface design. Hence, novel interface design guidance is produced considering device specific characteristics and context of use (Karabelas et al., 2003) emphasizing the need for continuous investigation and updates in the guidelines literature.

2.4 Tools for working with guidelines

Towards overcoming the limitations of guidelines mentioned in the previous paragraph, the creation of *Tools For Working With Guidelines* (TFWWGs) has been proposed. TFWWGs are defined as *any interactive software application or service that offers support for the use and integration of guidelines-related knowledge at any stage of the software development life-cycle* (Karampelas et al., 2003).

Other terms frequently found in the bibliography that are relevant to TFWWGs include:

- Computed-Aided Design of User Interfaces (Vanderdonckt, 1996)
- Knowledge-Based Support for the User-Interface Design Process (Lowgren, Nordqvist, 1992)
- Interface Design Guidance Systems (Blatt & Knutson, 1994)

Efforts in this direction started with the integration of guidelines into hypertext-based tools, which allow software designers to access design guidelines organised either as a database or hypertext (e.g., Perlman, 1987; Fox & Smith, 1989; Perlman, 1989; Iannella, 1992; Iannella, 1995; Vanderdonckt, 1995). Nevertheless, it appears that even solutions as such are restricted to offer passive and predefined support. This is the case with the only currently available software application that can be actually characterised as a tool for supporting the design and development of VEs is the prototype hypertext-based tool that was developed in the context of her PhD thesis by K. Kaur (1998); there is no actual interaction with the user, except from clicking on links to view different sections, and consequently there is no adaptation or even customisation to the user's role, task or needs; and the guidelines that are included in this prototypical development are very few (i.e., a dozen).

Regarding conventional (i.e., 2D) UIs, these shortcomings raised a compelling need for shifting from manual, passive and/or predefined support to active computer-supported use of guidelines (Grammenos, Akoumianakis & Stephanidis, 1999), by monitoring software development activities and providing automatically guidance and hints whenever necessary. This need has led to a number of active support tools (e.g., Kolski & Moussa, 1996; Farenc, 1997; Grammenos, Akoumianakis & Stephanidis, 2000). Still, most of them are mainly research prototypes and / or in-house tools developed and used internally by the people / organisations that have developed them.

Under the light of the above, the VIEW project (Contract no.: IST-2000-26089) conducted an investigation into existing TFWWGs (for conventional UIs), with the objectives of identifying, classifying, and studying existing support tools for the design and development of 2D environments (windows-like), and to investigate design requirements for successful TFWWG for VEs.

2.4.1 Classification of TFWWGs

The classification adopted for presenting the identified tools is based on the schemes suggested by Nakakoji, et al. (Nakakoji, Malinowski & Loewgren, 1996), Vanderdonckt (Vanderdonckt, 1999) and Grammenos, et al. (Grammenos, Akoumianakis & Stephanidis, 2000). According to the above, existing TFWWGs for conventional UIs can be classified in three categories:

(a) ***Tools offering passive support***: This type of TFWWGs allows software designers to access design guidelines organised either as a database or hypertext. Tools of this category have emerged as an attempt to make designers aware of existing studies on guidelines and style guides. A drawback of the "passive" approach, is that it assumes that the designers are already aware of the existence of the relative informational content, of whether it is applicable or not, and of how to access it using the system.

(b) ***Tools offering active support*:** An "active" TFWWG monitors software development activities and automatically provides guidance and hints as inferred necessary and relevant. A constraint-based design environment (Nakakoji, Malinowski, Loewgren, 1996) prevents designers from making designs that are inferred invalid by the system according to a set of predefined rules. This approach is not always applicable as not all design decisions can be classified a priori as right or wrong, or good or bad, at the point in time the decision is made.

This problem is addressed by a critiquing system (Nakakoji, Malinowski, Loewgren, 1996) that evaluates and critiques a partial design during the design process using predefined rules. In contrast to the constraint-based approach, designers are allowed to violate rules or recommendations by not responding to the critics. But again, this is not the most appropriate solution because sometimes it is much more efficient to avoid errors before making them rather than to make errors and detect them at a later stage. A sub-category of tools offering active support are the ***automatic design generation and evaluation*** tools that produce a user- interface design based on formal models specified by user interface designers (widely known as CADUI's). In addition, some of these tools are able to apply existing evaluation methods upon derived designs. Most of the available tools of this type are in the form of Software Development Environments (SDE's). Once the underlying models and knowledge required to map models into designs are developed, the approach relieves designers from making detailed user-interface design decisions. However, it is very challenging to completely model dynamic behaviour of users a priori, and in many cases it is impossible to codify design knowledge used by user-interface designers.

(c) ***Experience-based tools****:* Finally, there have been a few efforts aiming at consolidating past experience of an organisation into a usability case repository that can be used to recall past design problems, and related solutions, as well as to support human-factors knowledge persistence and evolution, as the organisation's expertise in a particular area grows and expands.

2.4.2 Reported requirements and techniques for successful TFWWGs

A significant amount of effort has been put in the past on creating TFWWGs for the development of conventional UIs. In fact, a significant volume of previous research has focused on what is needed for an effective, useful, and usable guidance system for supporting the development of 2D UIs. In some cases, the outcomes of this research may also apply to tools for the development of VEs.

For instance, A. Parush (Parush, 2001) suggests that the currently relatively fixed, predefined, and somewhat linear structure of both printed and online guidelines should be approached on the base of the following principles:

(a) **Modularity and Granularity**: The collection of online guidelines should be compiled in a modular fashion. The modules should be such as to enable both the construction and editing of the collection, on the one hand, and their use when needed, on the other hand. This structure can be broken down into several levels, form conceptual guideline to a single specific guideline. Users should be able to access the required granularity of information upon request.

(b) **Dynamic Evolution**: It is comprehensible that requirements and usage of guidelines evolve and change together with the design and development process itself, thus the structure of the guideline collection must lend itself to easy, smooth, and constant changes which are transparent to any builder or user of it.

(c) **Accessibility**: Just as the ability to easily create and modify guidelines must be a key feature of the online collection, a similar requirement is relevant for the actual user of the guidelines. The way guidelines are entered should be similar to the way guidelines are read or used, so any user of the system can easily perform both tasks Moreover, guideline collections must be accessible without the need for a large, complex, and cumbersome environment required for running it.

Blatt and Knutson (1994) conducted research on what is needed for an effective and useful Interface Design Guidance System (IDGS). Their research was based on the collection and analysis of existing tools and approaches, and the prototypical development of mock-ups of tools that were based on their preliminary findings and the evaluation of these prototypes with potential users during focus groups. According to their findings, in order for a tool to be useful in affecting interface design in a positive way and be adopted by the mainstream of s/w development, it must meet the following requirements:

(a) Provide design advice tailored to the developer's particular design problem (i.e., customisation according to context parameters).

(b) Provide design rationale for design issues with interactive examples of good and bad implementations.

(c) Provide the source code for UI examples and a way to integrate them into an interface under development.

(d) Allow the developer to view information such as user interface examples, design rationales, design rules, version evolution, guidelines, principles, requirements, user profiles and code to implement the example.

(e) Interface examples and information should be represented in different forms (e.g., audio, textual, and active interfaces).

(f) Allow easy specification of what information and examples are of interesting a specific design context situation, in order to allow the developer to focus on relevant information only.

(g) Provide a mechanism to expand the base of examples and design guidelines provided (i.e., support extensibility, maintenance, and version control).

(h) Provide some type of notepad to record ideas generated from user interface examples, regarding the new interface.

Vanderdonckt (1999), after going through five development milestones towards producing a high quality TFWWG, concludes by enumerating all the problems encountered and describing the undertaken countermeasures. Such problems include:

- guidelines increasing in time;
- guidelines dissemination throughout the literature;
- guidelines variations across contributing disciplines;
- guidelines variation in validity;
- decontextualisation of guidelines;
- guidelines variation in contents, presentation, level of detail, complexity, importance, scope, relevant development phase for use, and target development role;
- necessity yet insufficiency of guidelines;

- conflicts between guidelines;
- insufficient guidelines illustration, references, classification, and operationalisation;
- multiplicity of biographical references for a same guideline;

Vanderdonckt (1999) also presented a *general guideline model* targeted to solve some of the aforementioned problems. The proposed model includes the following attributes:

- Guideline identifier;
- A brief and representative title;
- A complete statement written in natural language;
- A list of bibliographic references quoting this guideline;
- The linguistic level to which the guideline is applied (one of: goal, pragmatic, semantic, syntactic, lexical, alphabetic and physical);
- The design ergonomic criteria respected by the guideline;
- The evaluation ergonomic criteria guaranteed by the guideline;
- The utility and usability factors satisfied by the guideline;
- A mathematical formula expressed in terms of the first order predicate logic;
- A rationale justifying the guideline;
- One or many positive examples depicting UIs in compliance with the guideline;
- One or many negative examples depicting UIs that violate the guideline;
- One or many exception cases, with one or many positive or negative examples each;
- The set of relationships with other guidelines according to a link typology;
- The interaction style(s) for which the guideline is valid;
- The interaction media related to the guideline.

Henninger (2000) presented a methodology and related tools for applying context-specific guidance, aiming at transforming usability guidelines into a proactive resource that s/w developers can employ early and often in the development process. Henninger states that the proposed methodology ensures conformance with established guidelines, but has also the flexibility to use design experiences to adapt the guidelines so that they meet the emergent and diverse requirements within modern UI design. Case-based organisational leaning technology is suggested to support the methodology and provide valuable resources for s/w developers.

Carter (1999) states that while integrating individual guidelines into development tools can support their use, the resulting complexity may generate usability issues of its own. Guidelines must first be usable for developers before they can improve the usability for end-users.

2.5 Limitations of TFWWGs

Overall, R&D efforts in the field of TFWWGs have focused on the effective and efficient delivery of such knowledge to potentially interested parties, putting limited attention to the process of its development. For instance, guidelines and standards represent a level of know-how and technology which renders the inclusion of industry in its preparation cycle indispensable. Every stakeholder accumulates experience and expertise in the context of the undertaken tasks, but in many cases this experience is not shared or made accessible to developers or designers except in the form of the released product.

2.5.1 Potential technology-based solutions

2.5.1.1 Tools supporting virtual collaboration

One of the main requirements of guidance development is collaboration. The popularity of the Internet have led to the development of on-line communities and virtual teams, allowing members of a team to be physical located anywhere in the world while working on a project. Online communities are defined as “cultural aggregations that emerge when enough people bump into each other often enough in cyber space” (Rheingold, 1994), while virtual teams are defined as groups of geographically, organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational tasks (Powell et al., 2004). Several studies concerning on-line communities revealed that their members share similar goals, interests, needs, or activities that provide the primary reason for belonging to a community (Preece and Maloney-Krichar, 2003). Members of an online community are engaged in intense interactions and shared activities; they have access to shared resources according to their access rights; they have a shared notion of language and communication protocols that predominate inside the community; they participate spontaneously and their social relationships and interactions promote the social construction of (tacit) knowledge and the diffusion of explicit knowledge (Agostini et al., 2003). One form of online communities, with specific goal of promoting the social construction of knowledge, is the community of practice. This is an informal but committed group of people that supports sharing and development of expertise in some specific area. The notion of a community of practice is ancient and taps into traditional human methods of passing on knowledge and skills (often effortlessly) within cohesive groups. This model of learning is reflected in traditional methods of apprenticeship. The development of a community of practice can be conceptualised as requiring both a sense of community (commitment, cohesion, trust, understanding, etc.) and ready access to a range of expert practice (Eales, 2004). The guidance development process within a virtual community can capitalise on the community's ability to share and develop expertise and knowledge. The loose relationship and commitment to an online community, however, do not apply to virtual teams, since they are committed and focused on the accomplishment of their specific goal. Virtual teams are often assembled in response to specific needs and are short lived. Nevertheless, this is not a defining characteristic of the virtual team, but rather a by-product of the specialized function they often serve. Distinctive features of virtual teams include their principal – and at times exclusive – reliance on information technology to communicate with each other, their flexible composition, and their ability, if necessary, to traverse traditional organizational boundaries and time constraints (Powell et al., 2004). The most important role in supporting either an online community or a virtual team is that of the technological infrastructure, namely the collaborative platform that facilitates all forms of communication. Communication in virtual communities occurs at two levels – explicit and implicit. Explicit communication can be asynchronous (e.g., e-mail) or synchronous (e.g. video conferencing). Implicit communication is conveyed by changes in shared artefacts according to socially accepted conventions. Effective support for collaboration requires both implicit and explicit communication mechanisms. In particular, there is a need for supporting the modification of a shared artefact, the observation of the modifications performed by others, and also the explicit recording of the rationale and objective of a modification as it occurs. Asynchronous communication is enabled between agents via message exchange. Synchronous communication requires support for simultaneous interaction by all team members involved in a particular activity. However, direct support for synchronous communication is missing from most systems (Barthelmess and Anderson, 2002). The most prevailing tools that have emerged to support human collaborative activities over networked systems are described below (Preece and Maloney- Krichar, 2003):

- E-mail is almost as ubiquitous as the telephone. Messages can be exchanged across different networks, in a variety of software platforms and applications and has become the most widespread and successful groupware application.
- Message boards / Forums. Participants of such forums may take time to reflect, compose, and edit items posted to the list that reflects their interests. Discussion threads provide historical context by linear organization of the topics of each conversation and support in-depth discussion. Many bulletin boards provide good search facilities that enable participants to search for topics, or people, or messages sent on or between particular dates, etc.
- Conferencing Tools (Voice and Video). Supporting real-time meetings is one of the most difficult tasks in a collaborative system. It requires high bandwidth to facilitate video exchange and expensive and complex devices to transmit video and audio, especially when there are multi-point connections in different locations.
- Instant Messaging / Chat. Chat systems are like instant e-mail, where people type and send instantly short comments or questions to each other. A good chat system impersonates a conversation easily, provided that it keeps track of the messages sent. If a large number of people participate in a chat, one might suspect that the conversation would get chaotic and be hard to follow. The trouble though in following a chat is not more than in a face-to-face meeting of the same number of participants, because the conversation is typically purposeful, the participants add

a few more conversational cues, like naming the person or topic to which they are referring, and the recent history allows people to review the conversational threads.

- Immersive Graphic Environments. These are synchronous, interactive, navigable environments with 3-D graphics, sound and animation, allowing the users to select a customizable character (avatar). They are highly versatile gaming, e-business, learning, and entertainment environments. There are several technological online communities that enable their members to converse with experts and find technological solutions to their problems, or to collaborate in open-source software projects such as the Linux community or in commercial products such as the Microsoft ASP.NET Developers Forum. Since an online community constitute a reliable framework to exchange knowledge and expertise between its members, it can be supported by a tool for working with guidelines in order to allow novice designers to request advice and benefit from the expertise of the senior designers who are members of the community.

2.5.1.2 Tools fostering knowledge organization

Virtual collaboration enables the members of a team to exchange knowledge and take advantage of the accumulated expertise of the senior members of the team or of the organisational memory of a company as stated in the previous paragraph. Organizational memories can be retained in six places: individuals, organizational culture, organizational transformations, organizational structures, organizational ecology, and external archives (Ackerman, 1998). This knowledge should be accessible to the members of the team through a series of retrieval and/or communication mechanisms, and, in parallel, suitable facilities should exist to support members' tasks (Eales, 2004). According to Zhuge (2002) the key to successful collaboration is the adopted communication approach that regulates the knowledge flow between the members of the team. Three alternative communication means used in online communities are identified:

- E-mail-based approach. This approach enables a team member to communicate with other members through e-mail. This process generates several implications since a member can receive several e-mails with the same subject at different periods, or receive several emails with different subjects but in the same short period. In both cases, the communication flow causes friction resulting in inefficient collaboration.

- Message-board-based approach. This is a centralised communication approach, where every team member sends questions or comments on the message-board and read the answers from it. The identified problem in this type of collaborative activity is that the logical order between different team members' knowledge is not reflected and this may cause information confusion.
- Knowledge-flow-based approach. This approach aims at overcoming the shortcomings of the previous approaches. Namely, a team member is only allowed to communicate with those who have direct work dependence relationship with him/her. Any team member can know the related predecessors' knowledge from the input knowledge flow, so unnecessary communication and frequent information exchange can be avoided. Additionally, general and historical knowledge is also available in the knowledge flow, and a new team member can raise his/her cognitive ability by following the knowledge flow. The appropriate mechanisms, however, should be available in the virtual collaboration platform to allow members of the team to record and retrieve knowledge. Furthermore, to support knowledge exchange in online collaborative environments, more mechanisms and activities are essential. The members of the teams must be able to (Kvana and Candyb, 2000):
    - generate and refine solutions in a personal work space;
    - access shared spaces for collaborative work;
    - develop solutions in the personal space and transfer them to shared space as required.

Thus, the requirements for mechanisms that facilitate the knowledge flow lead towards the enhancement of the existing online collaborative platforms, which need to acquire features of knowledge bases and knowledge portals in order to accommodate intensive collaboration and guidance demanding tasks such as user interface design. A knowledge base is defined as an Artificial Intelligence application that uses a knowledge database of human expertise for problem solving. Its success depends on the quality of the data and rules obtained from the human expert (Jackson et al., 1998). Knowledge portals extend this definition including aspects of cooperation between their members. Their aim is to make knowledge accessible to their members and to allow members to exchange knowledge. Knowledge portals usually specialise in a certain topic in order to offer deep coverage of the specific domain of interest. The portals are commonly built to include community services, such as online forums, mailing lists and relevant news articles. The systems also support the integration of personal and shared work-spaces for promoting circulation of knowledge among different activities and projects (Staab and Maedche, 2001 and Agostini et al., 2003). Knowledge bases or portals should also satisfy a list of requirements, such as to be able to support many users simultaneously, to work 24 hours/7 days per week, to be accessible through the Internet and to ensure the existence of the appropriate mechanisms to search or browse their contents and to amend the available information in a way so that they may be easily re-found. The knowledge base or portal must be adaptable to the information sources contributed by its providers - and not vice versa (Jackson et al., 1998 and Staab and Maedche, 2001).

A more systematic approach to the organisation of knowledge is to associate it with a specific context of work. This can be achieved through an enhanced mechanism which organises resources and information into project-related pools consisting of documents, folders, URLs, contacts and other types of resources, monitors user activities, automatically adds new resources to pools associated with active projects, and provides personal information management tools linked to individual projects (Kaptelinin, 2003). This mechanism thus reduces the amount of effort required from a user to complete a certain task and enable him/her to learn from previous experience (Henninger et al., 1997). In conclusion, support for collaboration between colleagues who are working at different locations through an enhanced knowledge base or portal, that allow, among other things, a project organisation of knowledge, enables users to participate in a shared environment and work independently, exploring at the same time a common knowledge repository and exploiting relative accumulated experience (Kvana and Candyb, 2000).

3. Overview and scope of the prototype

3.1 Objectives

As already stated TFWWGs have mainly focused on the effective and efficient delivery of such knowledge to potential interested parties. On the other hand the potential technology based solutions have several limitations. For instance, existing tools supporting virtual collaboration are focused mainly on communication within a virtual team, and support loose collaboration in the case of knowledge development and circulation. Additionally, in the field of knowledge organisation, knowledge portal focus mainly on the contribution and circulation of knowledge, while project based approaches satisfy several requirements but do not support the collaboration of multidisciplinary teams with a wide variation of roles, tasks and access rights on the shared resources based on a well established process. The solution proposed in this thesis builds on the fact that the aforementioned systems try to address different aspects of the same problem, but none of them can be though as a complete solution to the process of developing, communicating and using ergonomic knowledge. Therefore, this thesis proposes the application of an advanced web portal in the domain of tools for working with guidelines aiming, with the objective of unifying several well-established and reliable mechanisms described above, such as search and browse facilities, virtual online communities, communication and collaboration mechanisms, project administration facilities, and digital libraries, for the purposes of the development and practical use of guidelines and standards. Therefore, the proposed portal structure aims to facilitate the collaborative development of such knowledge by multidisciplinary teams, and to contribute towards (a) avoiding under-utilisation and regeneration of existing knowledge, (b) bridging the gap between knowledge developers and knowledge consumers, and (c) rapid initiation and promotion of guidance and standardization activities in various application domains.

3.2 Scope of this work

Virtual Reality (VR) technology is rapidly evolving, yet still in a state of flux. Nowadays, Virtual Environment (VE) applications are implemented and exploited as part of a number of industrial processes; nonetheless, this is mainly achieved on case-by-case basis, systematic approaches that build on a collective mindsets and long-term vision are not yet available. The massive, widespread research and development (R & D) process has today reached a level that makes a pan-European structuring and integrating effort an absolute necessity.

3.2.1 INTUITION Network Of Excellence

The main objective of the EC Network of Excellence (NoE) "*V**I**rtual reality a**N**b vir**TU**al environments appl**I**ca**TION**s for future workspaces*" (INTUITION) is to bring together leading experts and key actors across all major areas of VE understanding, development, testing and application in Europe in order to overcome fragmentation and thereby lead VR technologies to their full potential. The Network includes 58 partners and it is being coordinated by the Institute Of Communication And Computer Systems of the National Technical University of Athens in Greece. The INTUITION Network aims at:

- Systematically acquiring and clustering knowledge on VR concepts, methodologies and guidelines, to provide a thorough picture of the state of the art and provide a reference point for future projects development;
- Performing a review of existing and emerging VR systems and VE applications, and establishing a framework of relevant problems and limitations to be overcome;
- Identifying user requirements and wishes and also new promising application fields for VR technologies.

3.2.2 INTUITION Contributions to standards

Towards ensuring a smooth and efficient integration of VR technologies into industrial processes, a critical milestone set by INTUITION is to facilitate the systematic design and development of useful, ergonomically designed, usable, and safe VEs. In particular, workpackage[7] "*WP1.11 - Standards and Recommendations*" (WP1.11), focuses on:

- contributing to the establishment and maintenance of consistent, up-to-date and multi sector guidance, including standards, that VE designers and developers in Europe shall use to take human factors into account during the development life-cycle of their artefacts;
- ensuring the involvement of stakeholders;
- raising the awareness and capacity of European industry currently underutilising VR;
- providing efficient procedures and tools for the development of a coherent and complete range of guidelines and standards for VR.

The activities planned in WP1.11 involve, at a first stage, **collecting a record of existing knowledge and know-how**, including existing compilations of design rules, guidelines and standards, that could lead to guidance and ultimately to standardisation in field of VR in Europe. A subsequent step concerns **collaboratively reviewing the recorded knowledge** with the ultimate goal of identifying gaps and priorities towards standardisation in the field of VR. In this way, INTUITION aims at ultimately be in the position to move forward in **making concrete recommendations for new, or revisions of existing, VR guidelines and standards**. Indicatively, recommendations for new and revised standards may include, but are not limited to, *technical standards* (hardware and software, protocols, integration, etc.) and *usability standards* (basic functionality, navigation and interaction metaphors, functionality and behaviour a user can expect, positioning and behaviour of user interfaces, etc.).

Under the light of the above, Virtual Reality provides a great opportunity for utilising the proposed concept in a field where R&D regarding the development and use of guidelines and standards is not yet mature and few preliminary efforts towards this direction are conducted. On this context INTUITION WP1.11 leaded by FORTH-ICS aims at

[7] Workpackage leader: **FO**undation for **R**esearch and **T**echnology – **H**ellas, **I**nstitute of **C**omputer **S**cience (FORTH-ICS)

providing an infrastructure that will facilitate (i) the collaborative development and reviewing of guidelines and standards (as part of internal quality procedures within a corporation or formal procedures of a standardisation body), and (ii) the appropriate dissemination and ultimately practical exploitation of such knowledge in European industries.

3.3 Target users

A tool aiming at facilitating all the steps involved in the lifecycle of guidelines must support the activities and goals set by a wide range of users. More specifically the target user population of the system can be analysed taking into account the three main activities involved in the lifecycle of guidelines. In that way, the target user population includes: (a) users participating in the process of developing guidelines, (b) people that wish to take advantage of (i.e., use) the developed knowledge, and finally (c) users concerned with maintaining the system. *Knowledge development stakeholders* can be thought as persons that participate to the process of developing and maintaining knowledge with a distinctive role and responsibilities. Their background varies according to their role and responsibilities. On the other hand, *knowledge consumers* can be thought as the target user population of the knowledge developed and in the specific context can be divided to users that contribute to the production chain of a VR product, people that use VR products in their working environment, academics that conduct research in the domain of VR etc. Finally, the system administrators are responsible for administrating the system, i.e., keeping it functional and usable.

3.4 Preliminary design issues

Some preliminary considerations for achieving the objectives set by this research work concern the provision of three quality criteria. More specifically the issues that are of fundamental importance for the success of an application in the given context are usefulness (utility), usability and accessibility. Usefulness, can be though as the provision of a final product that incorporates any helpful mechanisms for achieving the users' goals. On the other hand, usability implies ease, effectiveness and efficiency in use and is concerned with the way that user tasks are carried out. Finally, accessibility concerns the provision of user interfaces that can be accessed and used by a variety of users, including people with disability.

4. Specifying a process for Collaborative Development of Guidelines and Standards (CDGS)

4.1 Methodology

For the establishment of the process to be followed by the INTUITION work on standardization, and instantiated in by the Pages for VR tool, several sources regarding standardisation, such as the Economic benefits of standardisation (Beuth Verlag, 2000), were examined. Additionally, information was extracted from the web resource do several standardisation bodies, such as ISO[8], BSI[9], ELOT[10], CEN[11], NSSN[12], ANSI[13], ECSS[14], WSSN[15], AECMA-STAN[16]. Finally, a thorough review of the processes followed by a number of standardization bodies was conducted through the examination of several procedural documents such as:

- the ANSI Essential Requirements Due process requirement for American National Standards (2004)
- the ECSS Internal Procedures regarding the:
  - Initiation of ECSS Standards (2003)

[8] http://www.iso.org

[9] http://www.bsi-global.com

[10] http://www.elot.gr

[11] http://www.cenorm.be

[12] http://www.nssn.org

[13] http://www.ansi.org

[14] http://www.ecss.nl

[15] http://www.wssn.net

[16] http://www.aecma-stan.org

  - Panel Review, Public Review and Steering Board Approval of ECSS Standards(2003)
  - Rules for the drafting and presentation of ECSS Standards(1999)
  - Guidelines to Authors of ECSS Standards to Facilitate Tailoring(1996)
- the AECMA-STAN General Process Manual (2000)
- the ISO/IEC Directives, Part1(2004) and Part2 (20004), etc.

Among the aforementioned sources of information, particular attention was paid to the standardization processes that involve the submission of results to external standardization bodies for approval. This approach was followed due to the fact that the INTUITION network scope does not involves the generation of new standards, but ultimately the proposal of concrete recommendations for new, or revisions of existing, VR guidelines and standards.

4.2 The CDGS Process

This section presents in depth a generic approach for the *Collaborative Development*[17] *of Guidelines and Standards* (CDGS). The presented process is appropriately supported through the **Pages** tool described in later sections.

As in general guidelines are directives to people in order to perform certain tasks effectively and efficiently, and standards are similar to guidelines, but in a stricter version, in terms of preparation, presentation and use (*for more details see section 2*), two slightly different variations of the CDGS process are presented, namely: (a) the *normal version,* which is targeted mainly to developing guidelines; and (b) the *strict version* which embodies a slightly more rigorous process for supporting the development of standards and which, in essence, is the normal version enhanced in order to support standardisation activities (e.g., within a corporate or of a standardisation organisation). The main difference between the two versions is that in the normal version the produced (guidelines-type) documents are subject to wide review **for gathering comments,**

[17] and subsequent maintenance

whereas in the case of the strict version the (standards-type), documents are subject to wide review **for achieving consensus**.

Overall, the potential guidelines and standards-type documents than may emerge by means of the CDGS Process include:

- Recommendations for Standards
- Standards
- Guides
- Technical Reports / Specifications
- Collections of Guidelines

The next two sections (i.e., 4.2.1 and 4.2.2) present the main structures and stakeholders involved in the CDGS Process, as well as an overview of the overall procedure. Then, sections 4.2.3 to 4.2.10 present each phase of the *normal version* of the CDGS Process - the stages of the process that need to be more rigorous in order to address standardisation (i.e., those that are part of the *strict version*) are explicitly identified and further analysed in separate subsections.

4.2.1 Key stakeholders in the CDGS Process

Research and development of guidelines and standards over a large area, such as that of the VR field, can be organised into general *Working Groups* (WGs) in order to allow coherent coordination, planning and programming of all activities in the context of the CDGS Process. The responsibilities and characteristics of each stakeholder involved in the CDGS Process are briefly analysed below.

Working Group Members (WGMs): These are persons or organisations with expertise or direct interest in a specific WG, and who can potentially participate in a new *CDGS Project*[18]. WGMs are also responsible for conducting, in a collaborative manner, an

[18] CDGS Project: A project for the Collaborative Development of Guidelines / Standard.

analysis of the state of the art within the WG in question, and brainstorm ideas for *New Work Proposals*[19] (NWPs).

Working Group Leader (WGL): A WGL is assigned to each WG. This is a person or organisation delegated to moderate (invite, accept, etc.) the WGMs, as well as co-ordinate technically all CDGS Projects within the corresponding WG.

Originator: This is a person or organisation proposing the preparation of a new set of guidelines or standards (i.e., a new CDGS Project). This is achieved by means of editing and submitting a NWP to a relevant WG.

Editor: This is typically the same person or organisation as the Originator of a NWP and, upon the approval of the NWP, is responsible for drafting the new set of guidelines or a standard, i.e., for running a new CDGS Project and editing the corresponding CDGS *Report*[20]. To this end, the Editor is also responsible for co-ordinating the work of all involved Authors (see below).

Authors: Upon approval of a NWP within a particular WG, the corresponding WGL specifies the team of experts (i.e., persons or organisations) who will participate to the new CDGS Project and contribute to the preparation of the corresponding CDGS Report in due time.

Board of Executives (BoE): This is a group of persons or organisations who are responsible for the operational work issues and general decision making with regards to the CDGS Process. The responsibilities of the BoE include:

[19] New Work Proposal (NWP): Is an abstract document that specifies the objectives of a new CDGS Project suggesting potential authors for the corresponding CDGS Report.

[20] CDGS Report: This is the main outcome of a CDGS Project, i.e., a collection of guidelines **or** (a set of recommendations for) a standard.

- the overall management of the WGs structure (including the assignment and replacement of WGLs
- the establishment and dissolution of WGs
- the delineation of WGs' scope
- coordination issues.

External Experts (ExEs): These are external persons or organisations (i.e., other than corresponding WGMs) with technical expertise related to the topic of a CDGS Project, and who are willing to review and provide their comments upon (draft versions of) the corresponding CDGS Report.

Interested Parties (IPs): Persons or organisations who represent the target market for CDGS Reports of a particular WG. Interested Parties are offered the right to vote and comment upon NWPs and (draft versions of) new CDGS Reports emerging from the corresponding WG.

Focal Points (FPs): These are persons or organisations within a WG (i.e., WGMs), nominated by the corresponding WGL, to administrate and act as contact persons to the WG's IPs.

Guidelines & Standardisation Experts (GSEs): These are persons or organisations with expertise in procedural and normative matters. These people are mainly responsible for the quality of the CDGS Report delivered by Editors.

4.2.2 Overview of the CDGS Process

This section provides a brief overview of the steps involved in the CDGS (see Figure 4:1):

1. **Brainstorming**. During this first phase[21] of the CDGS Process, the members of a WG (i.e., WGMs) participate to special interest discussions that focus on reviewing the state of the art within the corresponding WG (in terms of requirements for guidelines and/ or standards) and brainstorm ideas for new proposals (i.e., NWPs).
2. **New Proposal Preparation**. Once a new concept for a CDGS Project has been formed by an Originator, the preparation of the corresponding NWP is initiated:
    a. First, the Originator drafts a NWP (see footnote 19) and submits it to the WGL of a relevant WG. The NWP must specify the Editor and the Author(s) for the new CDGS Project.
    b. Then, the NWP is assessed by the corresponding WGL and BoE.
    c. Finally, upon approval by the corresponding WGL, the NWP is also assessed by IPs [22].
3. **New Project Set-up**. Upon approval of a NWP by the IPs, the WGL announces the launch of new CDGS Project. At this point, the Editor, in communication with the Authors, formulate an appropriate work plan (i.e., stages, deliverables and deadlines).
4. **Development of *Working Draft* (WD)**. The Editor along with Authors are responsible for carrying out the development of, and submitting for review, the first draft of the CDGS Report, namely the *Working Draft* (WD).
5. **Development of Consensus Draft (CD)**. In this phase, the WD will undergo a review by ExEs, GSEs and the relevant WGL. The comments of these people are then addressed, leading (through a number of iterations) to the *Consensus Draft* (CD).
6. **Restricted Review**. In this phase, the CD is put to the ballot among IPs, gathering their comments. The outcome of this phase is the *Revised Consensus Draft* (RCD).
7. **Public Review**. At this stage, the RCD is made publicly available (e.g., to industrial users) for gathering further comments and proceed to the creation of the *Final CDGS Report*.

[21] The Brainstorming phase is launched upon the generation of a new TA and ends upon withdrawal of the TA in question.

[22] This is introduced to ensure the commercial usefulness of the proposed project

8. **Publication and Maintenance.** The final stage of the CDGS Process is that of publication and maintenance of the Final CDGS Report. Publication is concerned with making the Final CDGS Report available for public use, and -if appropriate- submitting it to external standardisation body (-ies). At this stage only minor editorial changes, if and where necessary, are introduced into the final text. On the other hand, maintenance is concerned with keeping a Final CDGS Report up-to-date. A published Final CDGS Report should not be considered to be closed in terms of content and applicability. As guidelines and standards in the field of computer science, and especially in VR, are often revised in order to address new needs or are withdrawn as not applicable. To this end, Final CDGS Reports shall be often evaluated (e.g., annually). Depending on the results of (annual) evaluations, one of the following processes can be initiated:
    a. **Collaborative Revision of Guidelines and Standards** (CRGS). This process aims at revising, rather than developing, a CDGS Report, and is very similar to the CDGS Process.
    b. **Withdrawal**. This involves archiving and removal from public view / use.

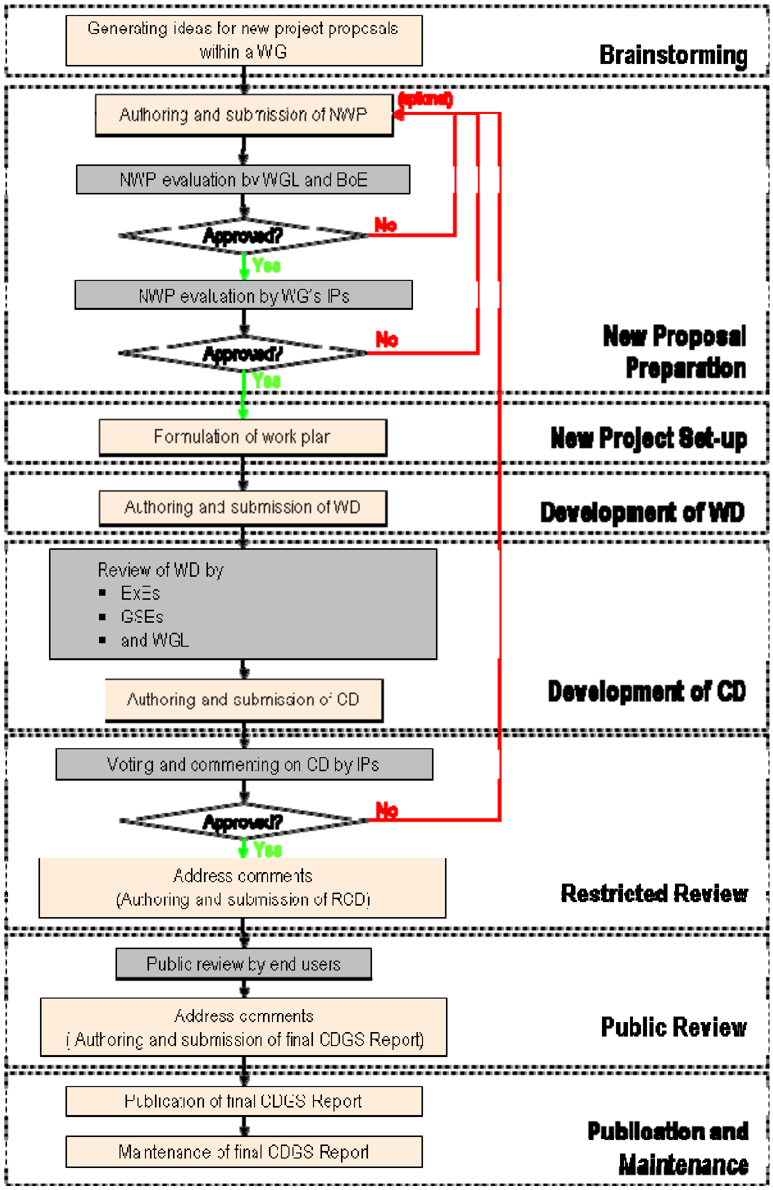


Figure 4:1: Overview of the CDGS Process

4.2.3 Brainstorming

In each WG, during this first phase of the CDGS Process, the corresponding WGL and WGMs, and potentially the corresponding ExEs and IPs, participate to special interest discussions that focus on reviewing the state of the art within the corresponding WG (e.g., in terms of the industry requirements for guidelines and/ or standards) and brainstorm ideas for new proposals (see Figure 4:2).

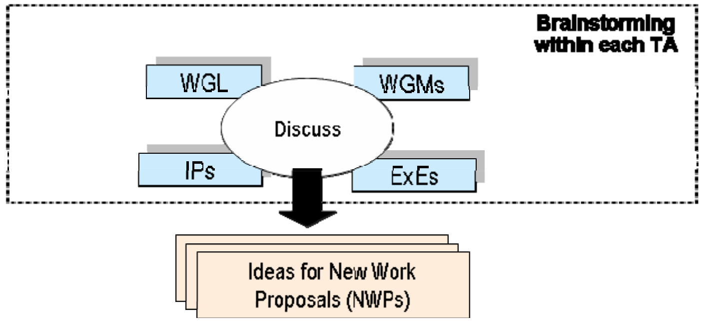


Figure 4:2: Brainstorming

4.2.4 New Proposal Preparation

Once a new concept for a CDGS Project has been formed by an Originator, the preparation of the corresponding NWP is initiated.

A. Preliminary Assessment (see Figure 4:3)

Once a new concept for a CDGS Project has been formed by an Originator, the preparation of the corresponding NWP is initiated. The Originator of a proposal is required to present a fully justified NWP. In order to achieve such an objective, the originator:

- Provides a first draft version of the NWP that will act as a starting point for a new CDGS Project.
- Provides all information requested in order to justify the need to proceed with the Project.
- Proposes Editor and Authors.

The information provided by the Originator is sent to the BoE and to the relevant WGL. The WGL is then required to evaluate the NWP and inform the BoE about the outcome of the evaluation. The BoE in turn decides whether to approve or not the NWP. In either case, the Originator of the proposal is informed. If the NWP is rejected by the BoE, the Originator may decide to proceed with a new, revised proposal by addressing the evaluation comments.

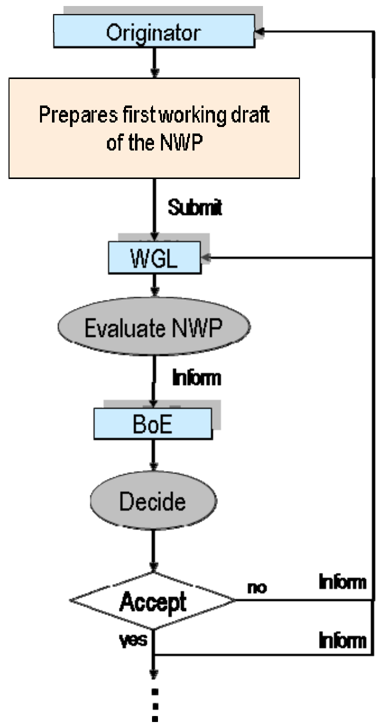


Figure 4:3: New Proposal Preparation – Preliminary assessment

B. Assessment by IPs (see Figure 4:4)

After the preliminary approval of the NWP by the BoE and the relevant WGL, the NWP is submitted to the Focal Point for the IPs of the relevant WG. The Focal Point, in turn, circulates the draft NWP to the IPs for review. After the completion of the review procedure by the IPs, the Focal Point is responsible for rationalising comments and votes. At this stage, the BoE and the corresponding WGL are informed about the outcome of IPs' ratings.

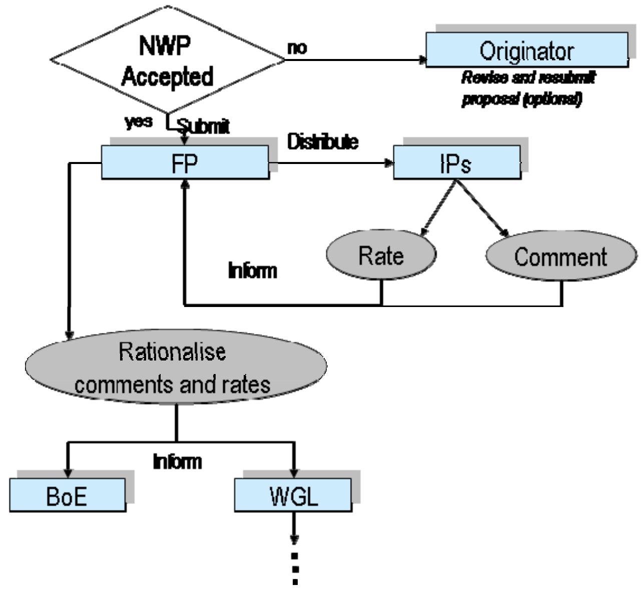


Figure 4:4: New Proposal Preparation – Assessment by IPs

C. Final Assessment (see Figure 4:5)

Having in mind the result of IPs commenting and ratings, the WGL evaluates the results and provides the BoE with suggestions for further action. The BoE makes the final decision about whether to accept or not the proposal in question. In any case, the Originator of the NWP and the WGL are informed about the final decision of the BoE. In the normal version of the process, the outcome of the IPs review process does not necessarily affect the acceptance or not of the proposal. The BoE can ignore the suggestions made by the executive and the review results.

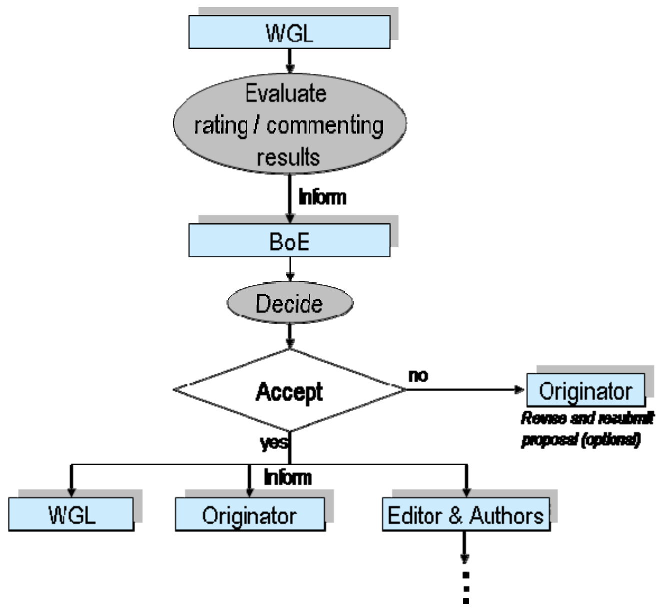


Figure 4:5: New Proposal Preparation – Final Assessment

STRICT VERSION:

(C. Final Assessment) In a strict process towards standardization the comments made by IPs and the results of the voting session must be taken in serious consideration by the WGL before making suggestions for further action. Disapproval of a proposal by IPs results to at least reconsideration (IPs review and comments) of the revised proposal that incorporates the comments made by IPs.

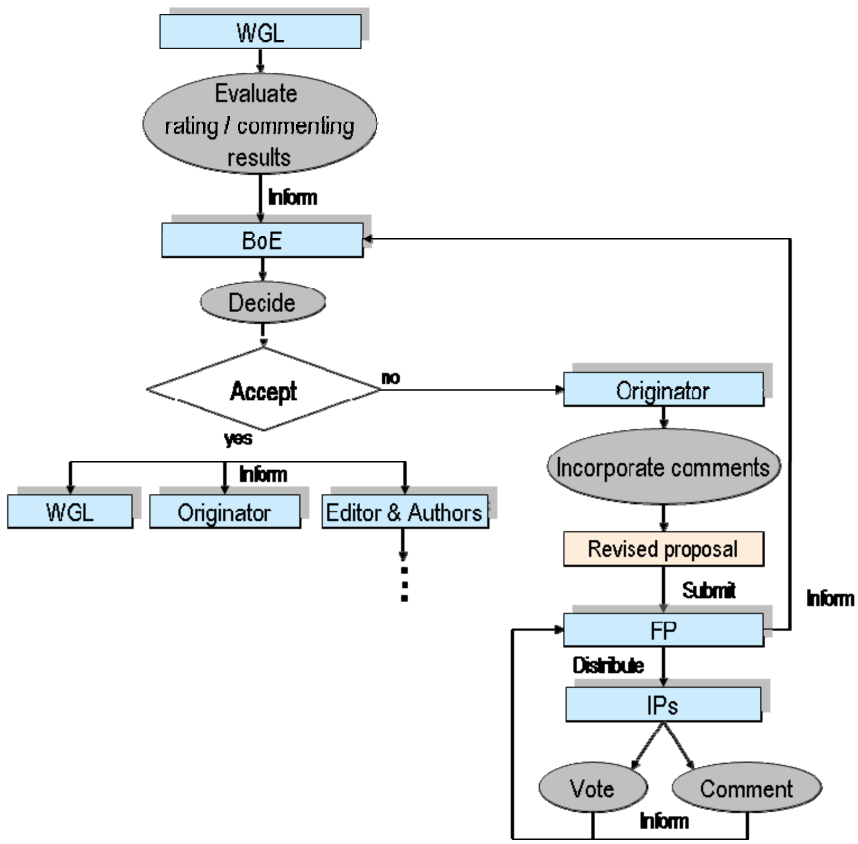


Figure 4:6: New Proposal Preparation – Final Assessment (Strict version)

4.2.5 New Project Set-up

Upon approval of a NWP by the IPs, the BoE announces the launch of new CDGS Project. The Editor, in communication with the Authors, formulates an appropriate work plan (i.e., tasks, deliverables and deadlines). After the definition of the work plan, the WGL must be informed. The WGL in turn evaluates the work plan and makes suggestions to the BoE about further actions (see Figure 4:7).

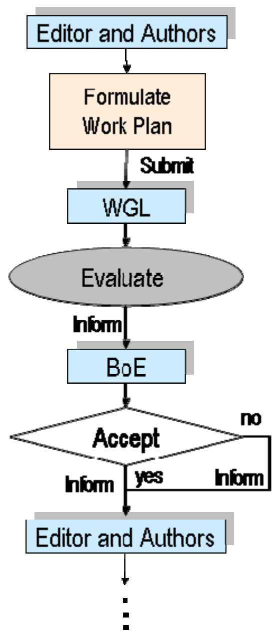


Figure 4:7: New Project Set-up

4.2.6 Development of Working Draft (WD)

The finalisation of the Work Plan is the starting point of drafting the CDGS Report. To accomplish this task, the cooperation of the Editor and the Authors is required. During the project, the Editor has the responsibility to coordinate Authors in preparing the WD. The WGL and the BoE are informed by the Editor in order to continue with the CDGS process (see Figure 4:8).

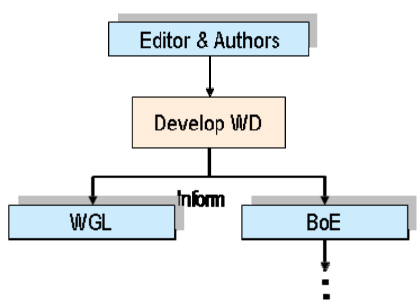


Figure 4:8: Development of Working Draft

4.2.7 Development of Consensus Draft (CD)

In this phase, the WD undergoes a review by ExEs, GSEs and the relevant WGL. The comments of these people serve as recommendations for improving the WD, generating the CD. After the creation of the CD, the WGL is informed and in turn provides the BoE with suggestions for further action. The BoE takes the decision to proceed or not with the restricted review phase (Figure 4:9).

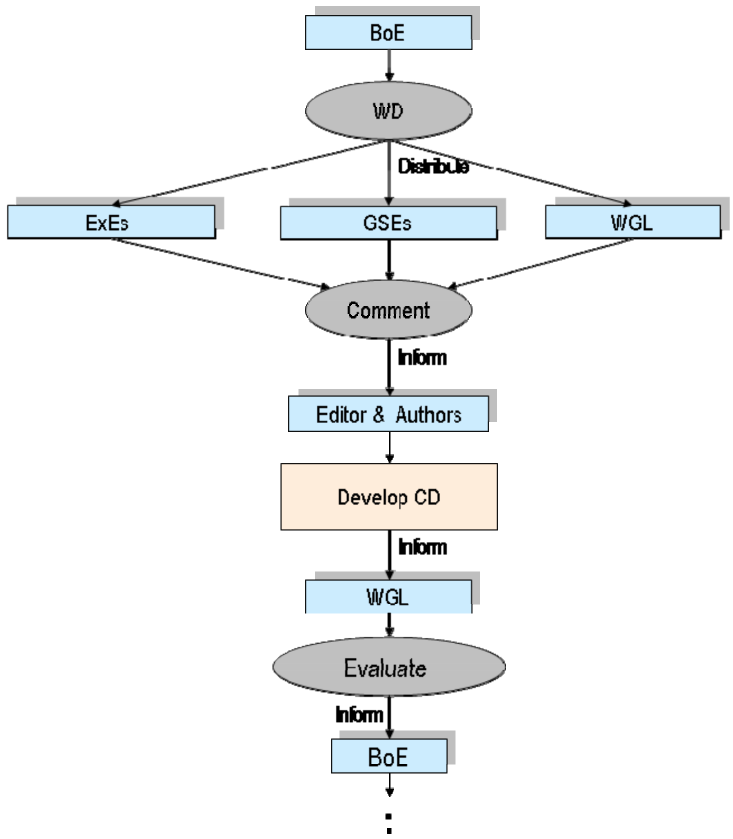


Figure 4:9: Development of Consensus Draft

4.2.8 Restricted Review

After the completion of the CD, this is distributed for voting. The FPs are responsible for the circulation of the CD to the WG IPs for gathering their votes and opinions. The IPs vote regarding the acceptance or not of the CD and provide comments if necessary. The WGL is informed about the voting results and evaluates them in order to make suggestions to the BoE for further action (see Figure 4:10).

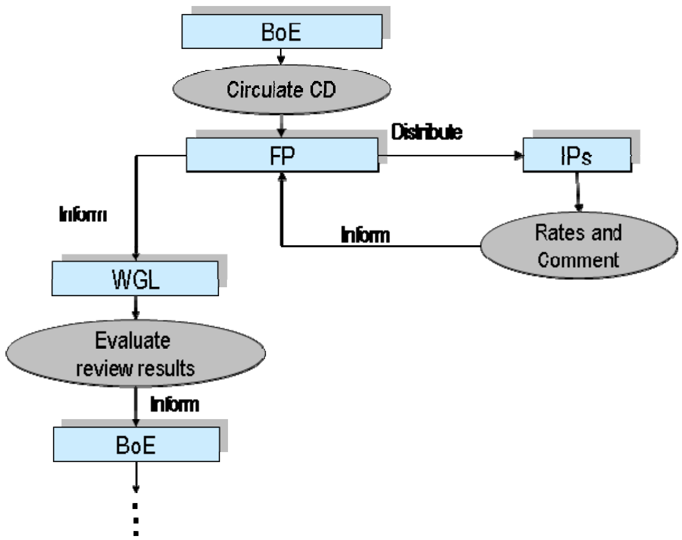


Figure 4:10: Restricted Review (1/2)

The rating results are used by WGL and BoE as additional material to help them making decisions, and do not restrict the BoE in accepting or not the CD. If the BoE decision is to continue with the CDGS process, then the corresponding Editor and Authors need to be informed about the voting results and the comments of the IPs. The Editor in cooperation with the Authors reformulates the project work plan in order to proceed with the revision of the CD taking into account the results of IPs rating. In this stage, the comments are used only as clues for improving the CD without the need for incorporation. After the CD revision, the WGL is informed in order to evaluate the CD and make suggestions for further action to the BoE (see Figure 4:11).

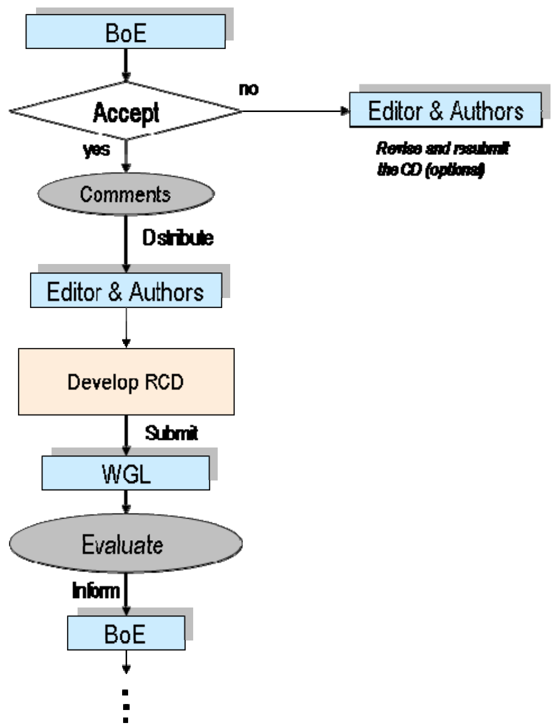


Figure 4:11: Restricted Review (2/2)

<u>STRICT VERSION</u>:

In case of a more strict process, the rates and comments made by IPs affect the decision made by the BoE about further action. If the CD is disapproved by IPs, the BoE must decide at least to reconsider the CD (authors are requested to incorporate comments and resubmit to IPs). If the CD is approved by the BoE, the comments made by the IPs are sent to the Editor and the PT to create a disposition plan. This plan is then submitted to the WGL and BoEs who in turn submit it to FPs for information. If the disposition plan is approved by the FPs, then the Editor is requested to incorporate all comments in the CD. After the stage of disposition, the WGL and BoEs are informed to proceed with further action (Figure 4:12).

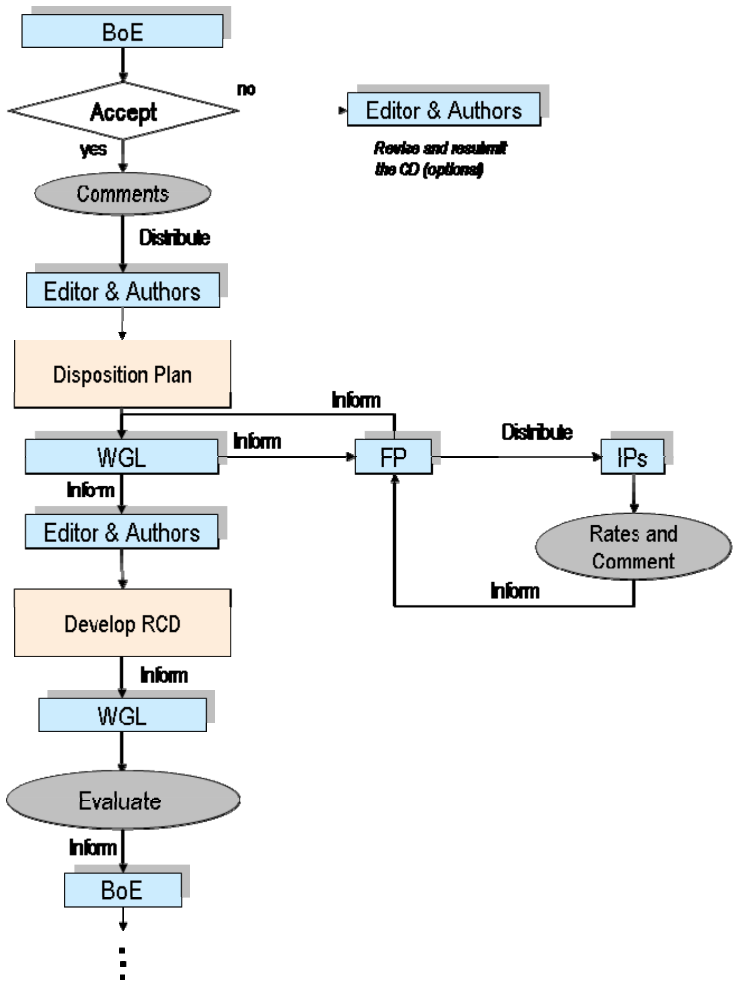


Figure 4:12: Restricted review on Consensus Draft (Strict process)

<u>Publication as a pre-version of Standard (optional)</u>

In case of a strict standardization process, a CD is evaluated:

- by the WGL for ensuring that the procedures for the preparation of standards have been followed
- by the PT Specialists for the quality of the CD.

The BoEs launch the publication of the CD as a pre-version of an external standardization body standard (Figure 4:13).

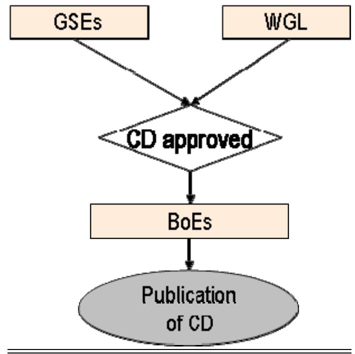


Figure 4:13: Publication as a pre-version of Standard

4.2.9 Public Review

At this stage, the RCD is made publicly available (e.g., to industrial users) for gathering comments in order to proceed to the creation of the Final CDGS Report. The reviewers of the RCD should be potential users of the guidelines or standards such as standardization bodies, organisations etc. After a certain time period has elapsed, all the comments made by the users are submitted to the Editor and Authors for further consideration (see Figure 4:14).

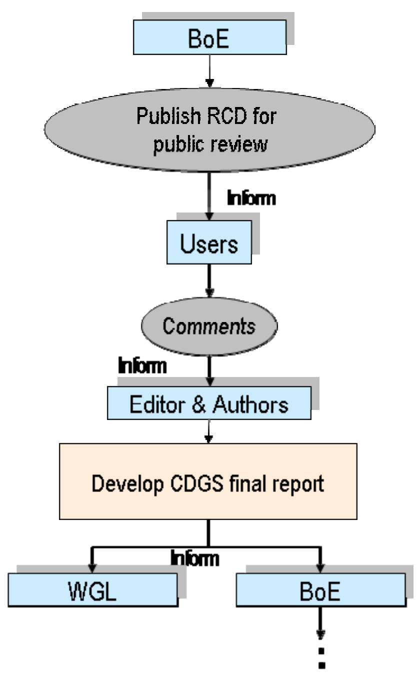


Figure 4:14: Public review

4.2.10 Publication and Maintenance

The final stage of the CDGS process is the publication and maintenance of the Final CDGS Report. Publication is concerned with making the Final CDGS Report available for public use. The potential users of the guidelines or standards are then able to issue comments on the collection in order to provide input for future maintenance activities. On the other hand, Maintenance is concerned with keeping a Final CDGS Report up-to-date. A published Final CDGS Report should be often evaluated (e.g., annually). Depending on the results of (annual) evaluations, one of the following processes can be initiated: Collaborative Revision of Guidelines and Standards (CRGS) or Withdrawal (see section 4.2.2).

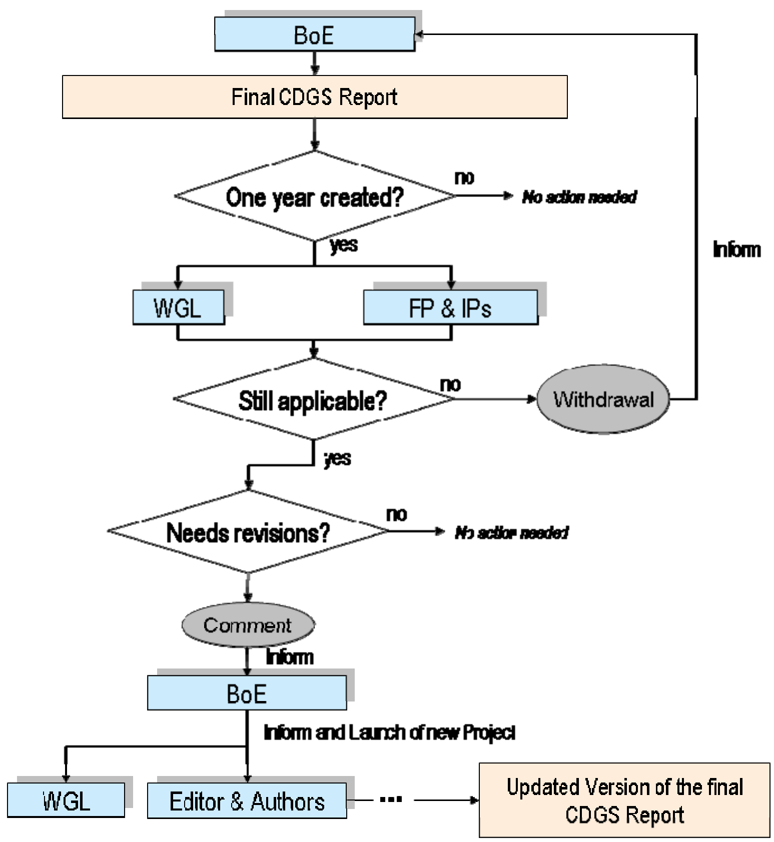


Figure 4:15: CDGS Report maintenance

4.2.10.1 <u>Interaction with External Standardization Bodies (ESBs)</u>

In case of a more strict approach towards standardization, the BoEs may wish to interact with External Standardization Bodies (ESBs) in order to receive comments on the Final

CDGS Report. These comments can be subsequently incorporated in the Final CDGS Report for ESB approval.

External standardization body Formal Vote

The BoEs:

- Prepares the Final CDGS Report (in electronic format) at least in English with the support of the PTL and GSEs.
- Submits the Final CDGS Report to the designated external standardization body using the relevant forms and envelopes (Figure 4:16).

External standardization body Approval

The external standardization body submits the results of the Final CDGS Report review procedure to the BoEs. The BoEs in turn submits the result to the Editor and the PT in order to prepare the disposition of comments. The new Final CDGS Report that results from the comments incorporation process is resubmitted to the ESB. The later procedure might be repeated more than once in order to achieve consensus between the two parties (Figure 4:16).

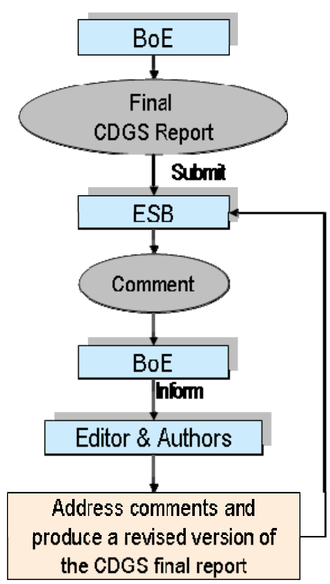


Figure 4:16: Interaction with ESB

4.2.11 When speed is of the essence

International standards are developed according to strict rules to ensure that they are transparent and fair. The reverse side of the coin is that it can take time to develop consensus among the interested parties and for the resulting agreement to go through the public review process. For some users of standards, particularly those working in fast-changing technology sectors, it may be more important to agree on a technical specification and publish it quickly, before going through the various checks and balances needed to win the status of a full Standard. Therefore, to meet such needs, ISO suggests a new range of "deliverables", or different categories of specifications, allowing publication at an intermediate stage of development before full consensus: Publicly Available Specification (PAS), Technical Specification (TS), Technical Report (TR) and International Workshop Agreement (IWA).

Overall, such interim documents, corresponding to different stages in the standardization process[23], may include:

- **Standard**
- **Publicly Available Specification**. A normative document representing the consensus within a working group.
- **Technical Specification**. A normative document representing the technical consensus within an ISO committee.
- **Technical Report**. An informative document containing information of a different kind from that normally published in a normative document.
- **International Workshop Agreement**. In a related move, the ISO Council has decided to add another mechanism to ISO's armory for providing normative documents which will not rely on the customary technical committee structures. Essentially this takes place through an open workshop mechanism whereby market players are able to negotiate in a workshop setting the contents of particular normative documents. The results of such workshops lead to the publication of documents designated as International Workshop Agreement.

[23] see http://www.iso.org/iso/en/stdsdevelopment/whowhenhow/proc/deliverables/pasetc.html

5. Design

5.1 User-centred approach

A user centered approach for the design and implementation of the Pages for VR tool has been followed. The aim was to develop a highly interactive and usable tool. User-centered design is an approach to interactive system development that focuses specifically on making systems usable for their users. It is an iterative process whose goal is the development of usable systems, achieved through the involvement of potential users during the design of the system.

There are four user-centered design activities which should take place during the design process, as shown in Figure 5:1:

1. understand and specify the context of use, the nature of the users, their goals and tasks, and the environment in which the product will be used
2. specify the user and organisational requirements in terms of effectiveness, efficiency and satisfaction; and the allocation of function between users and the system
3. produce designs and prototypes of plausible solutions
4. carry out user-based assessment

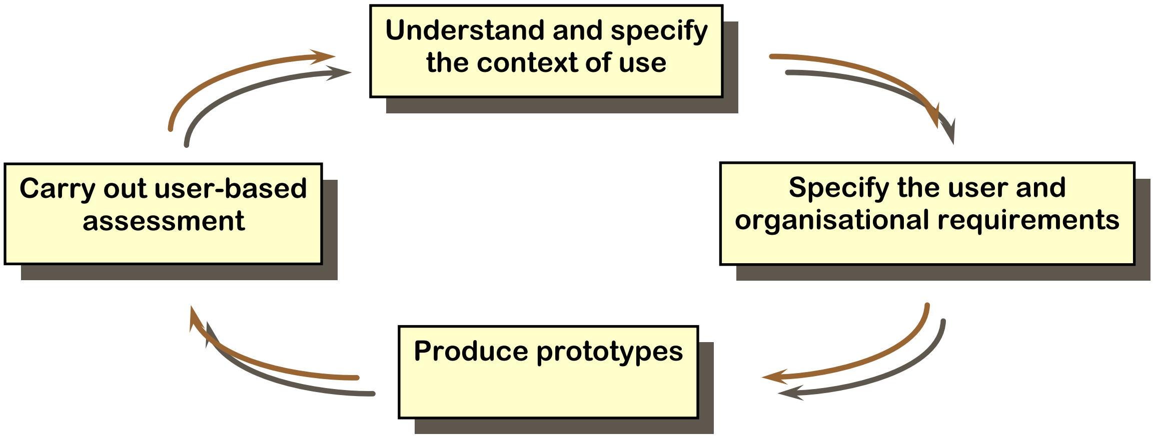


Figure 5:1: The activities involved in user centred design

5.1.1 Principles of User Centred Design

User Centred Design requires (Maguire, 2001):

- **The active involvement of users and clear understanding of user and task requirements.** One of the key strengths of user-centred design is the active involvement of end-users who can precisely convey to designers the context of use in which the system will be used. Involving end-users can also enhance the acceptance of the final outcome, since they would have participated in the system design.
- **The appropriate allocation of function between the user and the system.** It is important to determine which aspects of a job or task should be handled by users and which can be handled by the system. This division of labour should be based on an appreciation of human capabilities, their limitations and a thorough grasp of the particular demands of the task.
- **Iteration of design solutions.** Iterative software design entails receiving feedback from end-users following their use of early design solutions. These may range from simple paper mock-ups of screen layouts to software prototypes of greater fidelity. The users attempt to accomplish "real world'" tasks using the prototype. The feedback from this exercise is used to further develop the design.
- **Multi-disciplinary design teams.** User-centred system development is a collaborative process which benefits from the active involvement of various parties, each of whom have insights and expertise to share. Therefore, the development team should be made up of experts with technical skills in various phases of the design life

cycle. The team might thus include managers, usability specialists, end-users, software engineers, graphic designers, interaction designers, training and support staff and task experts.

The aforementioned principles were taken into consideration before and during the design of the tool.

5.1.2 Benefits of User Centred Design

Such a design process helps to:

- reduce the risk that the resulting system will under-deliver or fail
- avoid or reduce risks to their users and operators. A significant proportion of "human errors" can often be the result of a poorly designed user interface.
- meet user and organisational needs better
- avoid the risk of recycling of analysis, design and implementation, thus reducing development and maintenance time and cost
- are easier to understand and use, thus reducing training costs
- significantly improve the productivity of users and the operational efficiency of organisations allowing users to operate effectively and efficiently since they will be concentrated on the task rather than the tool.

The design of the infrastructure has undergone four main phases: user requirements analysis, task analysis, design and implementation.

5.2 User-requirements gathering

5.2.1 User Requirements gathering methodology

A thorough collection and elicitation of the tool requirements with respect to the characteristics and needs of potential users was made. The specific steps and the methodology followed in each of them are described in the following sections.

5.2.1.1 Study of Existing Literature

In order to acquire further insight into potential requirements for the tool, the currently published literature (paper or electronic), in reports, journals, conference proceedings, and books, was browsed as exhaustively as possible. Keywords and key subject titles, relative to the problem area, were identified and used to initiate and drive a search that was carried out, mostly, in two distinct pools of information:

- on-site libraries and records, and
- the World Wide Web (WWW)

The initial list of used keywords and subject is: Guidelines and Standards, Tools for working with Guidelines, Computer Aided Design of User Interfaces.

5.2.1.2 User Site Visits & Interviews

In order to acquire an insight into the target population of the tool regarding the use of computer systems and computer applications, typical daily tasks, working conditions, etc., and thereby capture potential users' requirements, it was decided to interview several members of the target user population (experimental scientists, instrument scientists, and data resource providers) and, in addition, some external to the potential users of the tool. Potential end-users of the tool, playing a key role towards a successful design of the tool, need to be prompted to offer their recommendations on the potential support to be offered by the tool. The process, generally, includes direct contact and real-time communication with potential users of the tool, which can either take place at the user's site or be performed remotely (e.g., using telecommunications). However, observation of the user at the actual workplace environment (e.g., by means of user site visits) is really beneficial and preferred, because users tend not to self-report actions accurately. In the latter case, interviews allow for a better interpretation of observations and for coverage of anything not observed.

5.2.1.3 Surveys

Surveys, constituting an inexpensive and widely used method for gathering user reflections and requirements, were also chosen with the intention to supplement the planned interviews and site visits. The overall idea was to collect enough data to perform quantitative analysis.

5.3 User requirements analysis

5.3.1 Target users

5.3.1.1 Knowledge development key stakeholders

The knowledge development key stakeholders are grouped in the categories listed below and are described analytically in section 4.2.1.

UG1 - Working Group Members (WGMs)

- ***UG1-G1:*** *Conduct, in a collaborative manner, analysis of the state of the art within a TA*
- ***UG1-G2:*** *Brainstorm ideas for New Work Proposals (NWPs).*
- ***UG1-G2:*** *Be reliable and good contributors in the development of knowledge (through CDGS Projects).*

UG2 - Working Group Leader (WGL)

- ***UG2-G1****: Moderate (invite, accept, etc.) the WGMs*
- ***UG2-G2:*** *Co-ordinate technically all CDGS Projects within the corresponding TA*

UG3 – Originator

- ***UG3-G1****: Propose the preparation of a new set of guidelines or standards*
- ***UG3-G2****: Edit and submit NWPs to a relevant TA.*

UG4 – Editor

- ***UG4-G1:*** *Draft sets of guidelines or standards.*
- ***UG4-G2:*** *Running new CDGS Projects*
- ***UG4-G2:*** *Editing CDGS Reports*
- ***UG4-G2:*** *Co-ordinate the work of all involved Authors*

UG5 – Authors

- ***UG5-G1:*** *Participate to CDGS Projects.*
- ***UG5-G2:*** *Contribute to the preparation of CDGS Reports*

UG6 - Board of Executives (BoE)

- ***UG6-G1:*** *Organize the operational work issues.*
- ***UG6-G2:*** *Manage the TAs structure (including the assignment and replacement of TACs)*
- ***UG6-G3:*** *Establish and Dissolute TAs*

UG7 - External Experts (ExEs)

- ***UG7-G:*** *Review and provide their comments upon (draft versions of) CDGS Reports.*

UG8 - Interested Parties (IPs)

- ***UG8-G1:*** *Vote and comment upon NWPs and (draft versions of) new CDGS Reports.*

UG9 - Focal Points (FPs)

- ***UG9-G1:*** *Administrate and act as contact persons to the TA's Interest Parties.*
- **UG10 - Guidelines & Standardisation Experts (GSEs)**
- ***UG10-G1****: Assure the quality of the CDGS Reports delivered by Editors.*

5.3.1.2 System administrators

UG11 - Knowledge administrators

This user category consists, in most cases, of users who wish to extend or update the knowledge base of the tool. Such users think of themselves first as scientists; administrative tasks distract them and frustrate them. It also transpires that their expertise in guidelines as well as in similar tools and procedures is, in the general case, low, if not inexistent. Thus, particular emphasis should be given to the ease of use and learnability of their tasks, as well as to the provision of extensive support and help.

By means of interviews and surveys, the following Knowledge Administrator goals were identified:

- ***UG11-G1:*** Perform (administrative) tasks as quickly as possible.
- ***UG11-G2:*** Stay away / eliminate mistakes while performing users / knowledge related administrative tasks.

- ***UG11-G3:*** Be consistent in their work.

UG12 - Support staff

The Support Staff group consists usually of people working as system administrators. This group is characterised by exceptionally high computer expertise (both in h/w and s/w issues) and their main concern is to keep the system up-and-running. They are mostly interested in being able to easily install applications, to monitor their proper operation, and to diagnose and promptly fix problems. Often, they have to install and maintain numerous different applications, and their expertise in each one of them may be little. The following primary goals of the Support Staff were identified:

- ***UG12-G1*****:** Obtain an overall understanding of the application's mechanics quickly without having to know/learn details about its content or functionality.
- ***UG12-G2*****:** Stay away from/eliminate mistakes.
- ***UG12-G3*****:** Recover easily and quickly in case such mistakes occur.
- ***UG12-G4*****:** Avoid total loss of data.

5.3.1.3 Knowledge end-users

UG13 – "VE Creators"

In general, VE Creators can be described as highly trained, salaried employees who, collaboratively, contribute to the production chain of a VE. VE Creators are very experienced in their job, have high educational levels, and relative high frequency of computer use and computer expertise. Their need for training support is moderate and their perception is that computers are essential to their jobs. Since they are all very familiar with Windows-type interfaces and web browser based interfaces, it is expected that learning to use a novel application that follows established conventions and designs in these fields will be easy, fast and intuitive.

VE Creators are what we usually call power users. These are people who require maximum efficiency and effectiveness, even if sometimes this has to be traded-off against ease of use and learnability. Furthermore, since they already have a particular mode and model of work, it can be very hard (and sometimes unpleasant) for them to employ tools or methods that require some form of adaptation of their well-established procedures. Although all VE Creators probably have some exposure to guidelines-related knowledge (different kind of knowledge for each one of them), it is usually the test/evaluation experts who have the most extensive expertise in this field.

By means of interviews and surveys the following goals of VE Creators were identified:

- ***UG13-G1:*** Be reliable and good contributors in the development of a specific VE.
- ***UG13-G2:*** Be proactive not reactive.
- ***UG13-G3:*** Achieve a sense of mastery and feel that their contribution (work) is unique.
- ***UG13-G4:*** Personalise (appropriate) existing guidelines-related knowledge.
- ***UG13-G5:*** Get the work done on time and well.
- ***UG13-G6:*** Reuse working (i.e., good) solutions.
- ***UG13-G7:*** Keep a sense of continuous learning and improvement in the field.
- ***UG13-G8:*** Provide their products/artefacts in an appropriate and (re-) usable way.
- ***UG13-G9:*** Be free during their tasks from as many as possible distractions and restrictions caused by technical and environmental limitations (e.g., avoid changing machines and location while performing a certain task).
- ***UG13-G10:*** enjoy their work.

UG14 – VR system end-users

VR System end-users are trained, salaried employees who, individually or collaboratively, use VR applications in their working environment, mainly in domains such as design, manufacturing, planning and layout applications, as well as in training and simulation, visualisation and marketing. Currently, VR System end-users belong mainly to the following market sectors:

- Defence and Government (D&G) – military and Government agencies world-wide plus academic and corporate ventures that are largely Government funded.
- Design and Engineering (D&E) – CAD/CAM, architectural, and other engineering-orientated market sectors.

- Industry and Business (I&B) – industry sectors such as mining, oil & gas, other manufacturing sectors, as well as enterprise-level visualisation and information management.
- Medical and Scientific (M&S) – non-Government medical and scientific research organisations and corporations.

VR System end-users, despite the variation in their academic backgrounds, are in, general, highly educated, with high computer experience, and moderate training support needs. Their perception is that computers are essential to their jobs. These users are anticipated to be using the tool less frequently than VE Creators, and usually for different reasons (e.g., learn about safe utilisation of VEs and not for improving their skills). Furthermore, they mostly do not have any experience in working with guidelines and support tools. Therefore, for them ease of use and ease of learning are of paramount importance, even if this implies in some cases a trading off with respect to the overall system efficiency and effectiveness.

By means of interviews and surveys, the following VR System end-users goals were identified:

- ***UG14-G1:*** Make best and safest use of VEs.
- **UG14-G2:** Preserve privacy.
- **UG14-G3:** Have the work done as quickly as possible.
- **UG14-G4:** Enjoy their work.

UG15 - Scholars, academics and researchers

In addition to the above UGs, another user group (i.e., users who will mostly be satisfied with the primary users' interface(s), but have specific additional needs) has been identified, namely scolars, academics and researchers. This UG, in relation to the rest of UGs, can be considered more or less "horizontal", since such users may cumulate any of the *UG11*, *UG13*, and *UG14* goals. However, UG15 appear to have additional requirements, such as, for example, the need to access tutorial sessions, extensive reference material, evaluation of knowledge acquisition, etc.

The members of UG15 have diverse levels of computer and VR-related expertise, as well as knowledge of guidelines and relevant tools. Their main concerns are ease of learning and availability of support, as well as provision of extensive reference/study materials appropriate for different levels of expertise. Furthermore, these users are often interested in tools for knowledge consolidation and testing.

By means of interviews and surveys, the following scolars, academics and researchers goals were identified:

- ***UG15-G1*****:** Achieve a sense of mastery and feel that their (work) contribution is unique.
- ***UG15-G2:*** Get the work done well and on time.
- ***UG15-G3*****:** Keep good record of previous work so that old working (i.e., good) solutions can be easily identified and reused.
- ***UG15-G4*****:** Maintain a sense of continuous learning and improvement of their skills.

5.3.2 Functional and Non-Functional Requirements

System Requirements capture the intended functionality and behaviour of the system so as to drive architectural decisions and validate the architecture. In general, requirements are partitioned into *functional requirements* and *non-functional* requirements. Functional requirements are associated with specific functions, tasks or behaviours that the system must support, while non-functional requirements are constraints on various attributes of these functions or tasks associated with the user's goals. In other words, functional requirements clarify the functionality required by the system towards supporting effectively (an agreed set of) user tasks, whereas non-functional requirements specify the required behaviour of the system towards supporting efficiently the user goals. It can be helpful to think of non-functional requirements as adverbially related to tasks or functional requirements: how fast, how efficiently, how safely, etc., is a particular task carried out by a particular system.

5.3.2.1 Functional requirements

This section presents the functional requirements of an advanced, web-based portal to serve as an environment for enabling (a) the cooperative development of guidelines and standards by knowledge developers, and (b) the practical use of guidelines and standards by knowledge consumers. These requirements constitute the basis of the Pages for VR tool.

Functional requirements for Knowledge development key stakeholders

Online communities: Online communities that offer virtual communication and collaboration facilities (Preece & Maloney- Krichar, 2003), such as message boards, chat, web-mail and documents area can be used to support the Working Groups and therefore to host brainstorming sessions, and offer the functionality needed to initiate new knowledge development activities.

Reviews: The process of knowledge development entails the need of formal and informal reviewing of the developed documents to achieve quality and consensus. A reviewing mechanism is therefore required that is flexible enough to be used in various occasions and for various purposes. This can be achieved by incorporating a dynamic questionnaire facility that enables the development of questionnaires that can be subsequently used in the context of review sessions. Additionally, appropriate functions are required to produce collective results of the review sessions to be used by knowledge development stakeholders to make decisions for further action.

Project administration: Editors and authors should cooperatively develop the knowledge stemming from a thematic area. To achieve this goal, a mechanism facilitating the administration of projects is required (e.g., see Jurison, 1999 and Kerzner 1989). This mechanism enables the Editor to divide a knowledge development activity into tasks, as well as to assign tasks to authors and deadlines to tasks. Furthermore, the project administration functionality should provide the means for project members to cooperate in order to receive and address comments, inform Editor about the completion of tasks, deliver task results etc.

Voting: Consensus in the context of a thematic area can be achieved through voting sessions. These should be facilitated by a voting mechanism that enables members of a Working Group to express their opinions regarding specific topics.

Notifications: In order for the knowledge development process to be completed successfully, many steps have to be made that require intense interaction and actions by various stakeholders. The aforementioned aspects entail the need for a mechanism that notifies participants about results of processes such as voting sessions, or about actions that have to be performed. This can be achieved with the help of a notification facility that sends personal messages to each member of the process regarding the member's role.

Knowledge development activities overview: The coordinators of activities play a very important role, and their actions are very critical for the successful development of knowledge (e.g., see Eales, 2004). In order for these stakeholders to have an overview of the process, a specialized task manager mechanism is required. This mechanism should provide evidence about the status of the each development process and the steps that must be subsequently performed.

Functional requirements for Knowledge consumers

Digital Library: Knowledge users wish to gain access to the knowledge developed within the Working Groups. One of the most effective ways to organize knowledge in the context of a web portal is the provision of a digital library (Anderson, 1997 and Fox et al., 1995). A digital library based on facilities such as browse, search, rating and bookmark functionality can provide quick access and use of the stored guidelines and standards, and additionally enables users to create and maintain well-structured personal views of the available knowledge.

Knowledge profiles: Knowledge users can use this mechanism to create personal profiles of interests to be used when performing knowledge retrieval operations in the digital library (e.g., Kima & Chan 2003, Sugiyama, Hatano, Yoshikawa 2004). More specifically, these profiles are used to filter all the results retrieved by user actions.

Online communities: Online communities (see previous section) to support knowledge consumers in their task of seeking information and knowledge by a wide range of sources.

Courses: Users that wish to use the stored guidelines and standards as reference material for academic or general purposes will particularly appreciate the provision of a course mechanism. The functionality provided by this mechanism enables users to organize knowledge into a hierarchy of chapters and ultimately access interactive or printable versions of their artifacts.

Functional requirements for System administrators

Knowledge administration mechanisms: Users that wish to extend or alter the knowledge base must be provided with mechanisms for administrating:

- **Collections of knowledge:** Provide the ability to administrate knowledge collections along with the administration of user subscriptions to these collections.
- **Resources types:** Mechanisms that alter the contents of the knowledge base in terms of the possible resource types that can be contained in the knowledge base.
- **Resources:** Mechanisms for enriching and administrating the contents of the knowledge base.

System administration mechanisms: Users assigned with the responsibility of maintaining the integrity of the system and performing administrative tasks must be provided with additional mechanism for:

- **System run time administration:** Provide mechanisms that enable the run time administration of the system in terms of users, user roles, content, etc.
- **System recovery:** Automated process of recovery after h/w or s/w failures.
- **System set-up:** Automated tools for making the system available on-line

5.3.2.2 Non-Functional Requirements

Although the provision of the above mentioned functionality is of high value to the user, the user might end up in disliking the system just if some of his/her goals (e.g., to perform administrative tasks as quickly as possible; to stay away from big mistakes; to be consistent) are violated while using the system. Thus, identified user goals have been translated into non-functional requirements as follows:

<keyword> : <non-functional requirement>

Non-functional keywords include, but are not limited to: Usability, in terms of Learnability, Efficiency, Memorability, Errors, Satisfaction (Nielsen, 1993); Security; Reliability; Maintainability; Portability; Extensibility; Reusability; Resource utilisation; Operability; and Accessibility. For instance,

- The goals UG1-G2 (i.e., Be reliable and good contributors in the development of knowledge) and UG11-G1 (i.e., be reliable and good contributors in the development of a specific VE) imply high efficiency, reliability, and resource utilisation of the tool.
- The goal UG2-G2 (i.e., Co-ordinate technically all CDGS Projects within the corresponding TA), UG4-G2 (i.e., Co-ordinate the work of all involved Authors) and UG6-G2 (i.e., Manage the TAs structure including the assignment and replacement of TACs) implies for the tool high efficiency and resource utilisation.
- The goals UG1-G1 (i.e., Conduct, in a collaborative manner, analysis of the state of the art within a TA), UG2-G1 (i.e., Moderate the WGMs), UG4-G1 (i.e., Draft sets of guidelines or standards.), UG4-G2 (i.e., Running new CDGS Projects), UG4-G2 (i.e., Editing CDGS Reports) and UG8-G1 (i.e., Vote and comment upon NWPs and new CDGS Reports.) imply the tool's ease of everyday operation.
- The goals UG11-G3 (i.e., achieve a sense of mastery and feel that their work is unique) and UG12-G2 (i.e., be on the top of new VR technologies) imply that extensibility of the tool should able to cope with the fast rate of the VR technologies evolution.
- The goal UG13-G2 (i.e., stay away / eliminate mistakes while performing users / knowledge related administrative tasks) means that users should make as few, and non-catastrophic, errors as possible when using the system.
- The goal UG11-G4 (i.e., become liberated during their tasks from as many as possible distractions and restrictions inferred by technical and environmental limitations, e.g., avoid changing machines and location while performing a certain task) set the requirements for a portable tool.
- The goal UG11-G9 (i.e., joy work) arises the need for a pleasant tool, i.e., for moderate to high levels of subjective satisfaction.

5.4 Task analysis

The purpose of the Task Analysis phase in the context of the Pages for VR tool was to define which tasks are to be supported by the system and how. In order to describe the list of system tasks and their major characteristics, task data collection techniques were employed. Based on the requirements for the tool as these were defined in the previous section, user duties and tasks according to different user roles were determined and analysed.

As a result of the previous phases of the design process, different user roles were identified which affect the categorization of user tasks. User roles and tasks are analysed in the following sections.

5.4.1 Digital Library

User tasks identified

- T1.Search resource
- T2.Category based browsing
- T3. Review resource
- T4.New resource type
- T5. Select user profiles
- T6. Add resource
- T7.Edit resource
- T8.Rate resource
- T9.Delete resource

Table 5:1 displays the mapping of the aforementioned user tasks to user roles.

Digital Library		
User Category	**User role**	**User Tasks**
Knowledge end-users		T1, T2, T3, T5, T8
Knowledge administrators		T1, T2, T3, T4, T5, T6, T7, T8, T9
System administrators		T4, T6

Knowledge development key stakeholders	Working Group Members (WGMs)	T1, T2, T3, T5, T8
	Working Group Leader (WGL)	T1, T2, T3, T5, T8
	Originator	T1, T2, T3, T5, T8
	Editor	T1, T2, T3, T5, T8
	Authors	T1, T2, T3, T5, T8
	Board of Executives (BoE)	T1, T2, T3, T5, T8
	External Experts (ExEs)	T1, T2, T3, T5, T8
	Interested Parties (IPs)	T1, T2, T3, T5, T8
	Focal Points (FPs)	T1, T2, T3, T5, T8
	Guidelines & Standardisation Experts (GSEs)	T1, T2, T3, T5, T8

Table 5:1: Mapping of user tasks to user roles for the digital library

The hierarchical analysis of the task identified above is schematically represented in Figure 5:2 to Figure 5:10.

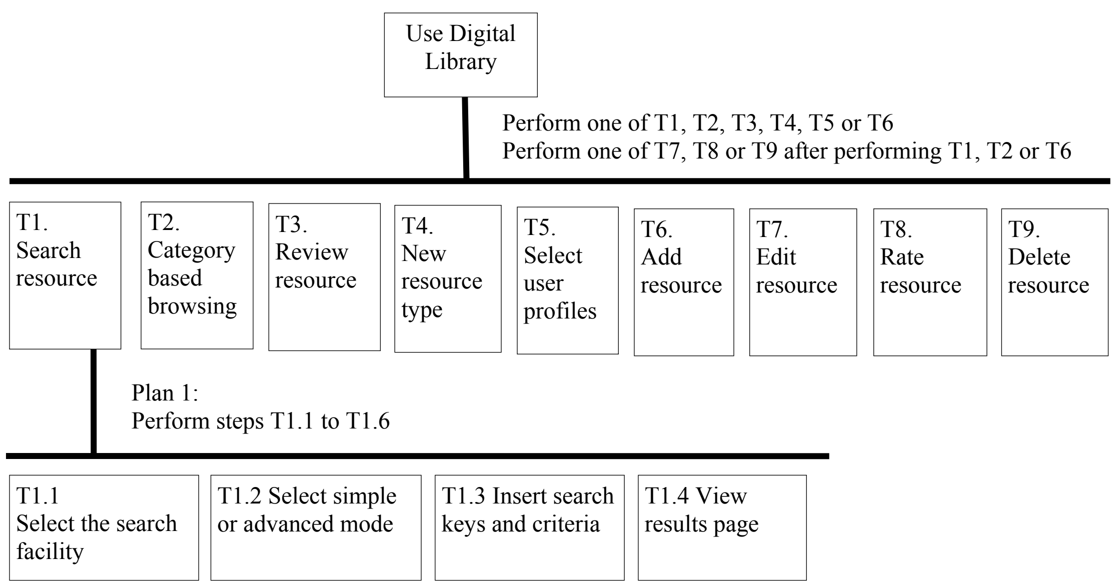


Figure 5:2: Task T1: Search resource

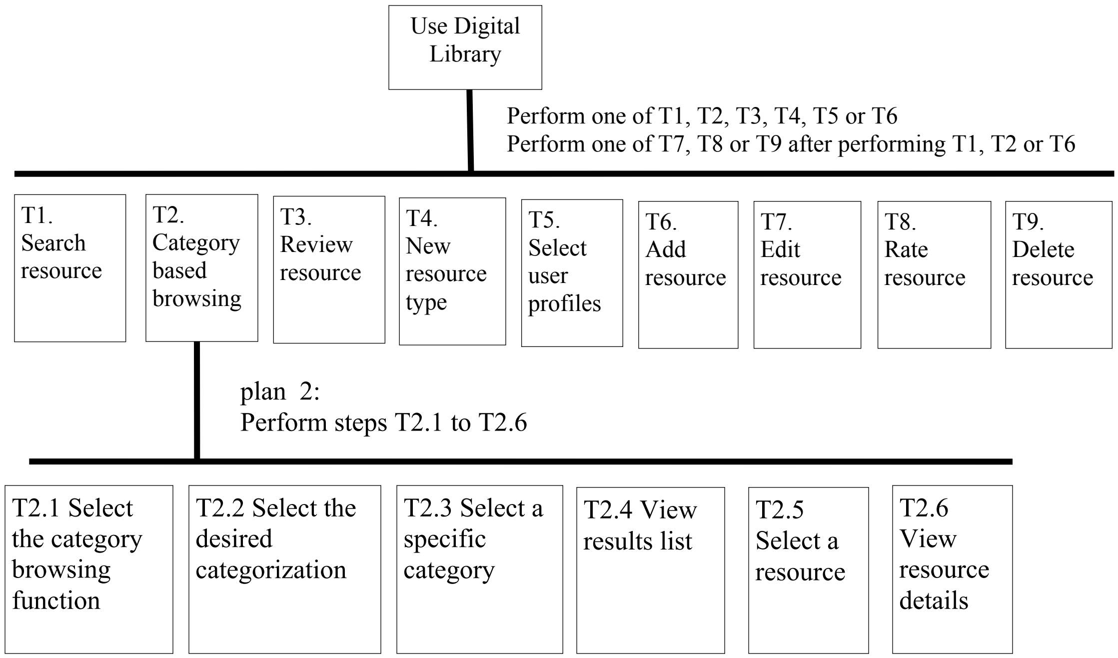


Figure 5:3: Task T2: Category based browsing

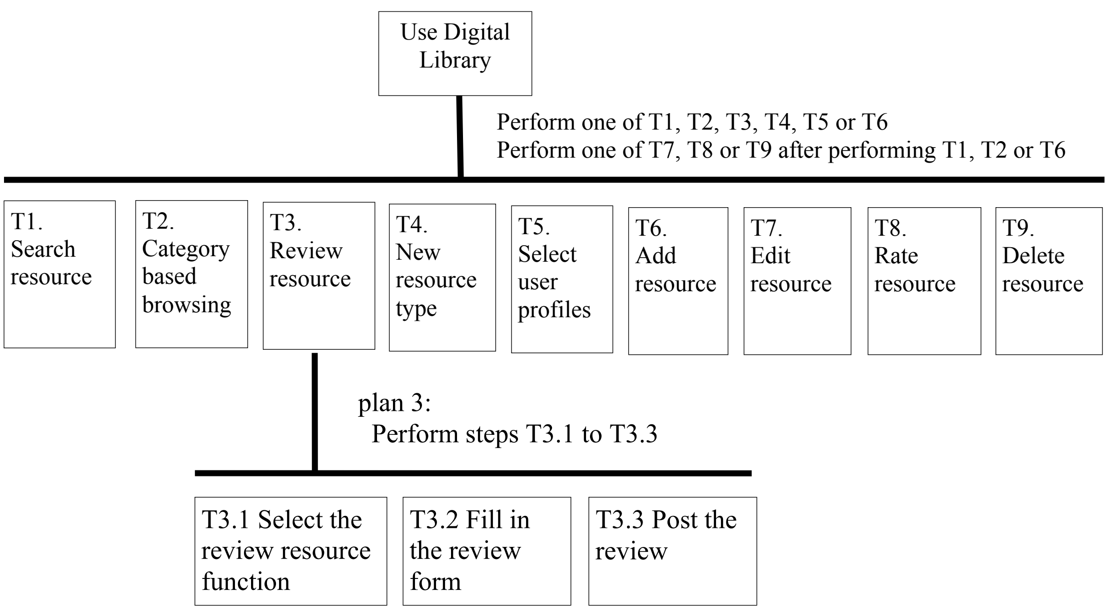


Figure 5:4: Task T3: Review resource

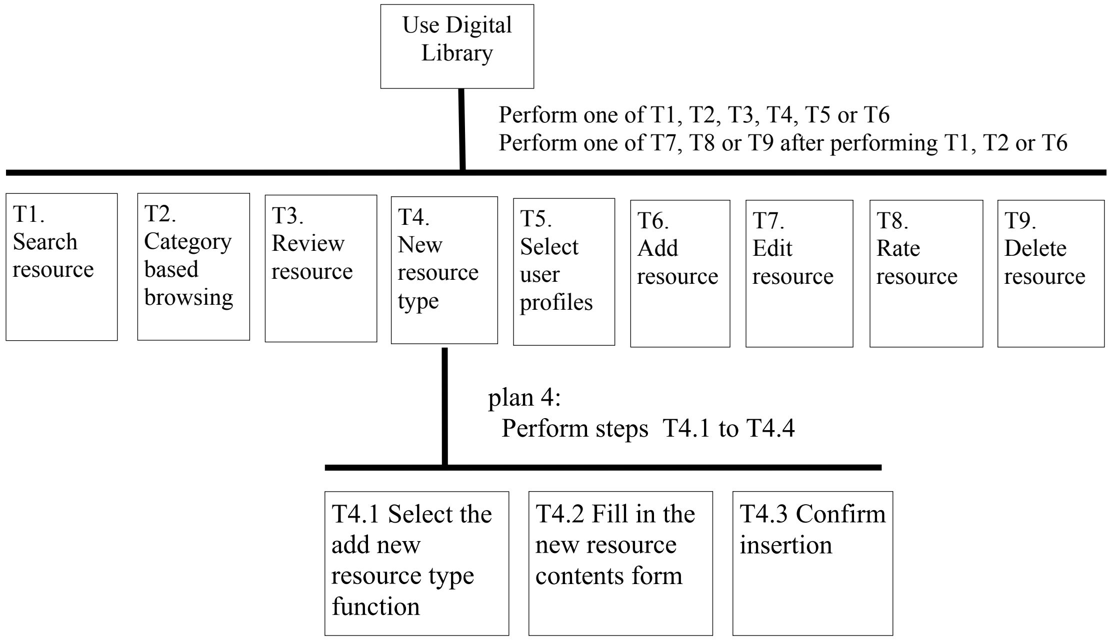


Figure 5:5: Task T4: New resource type

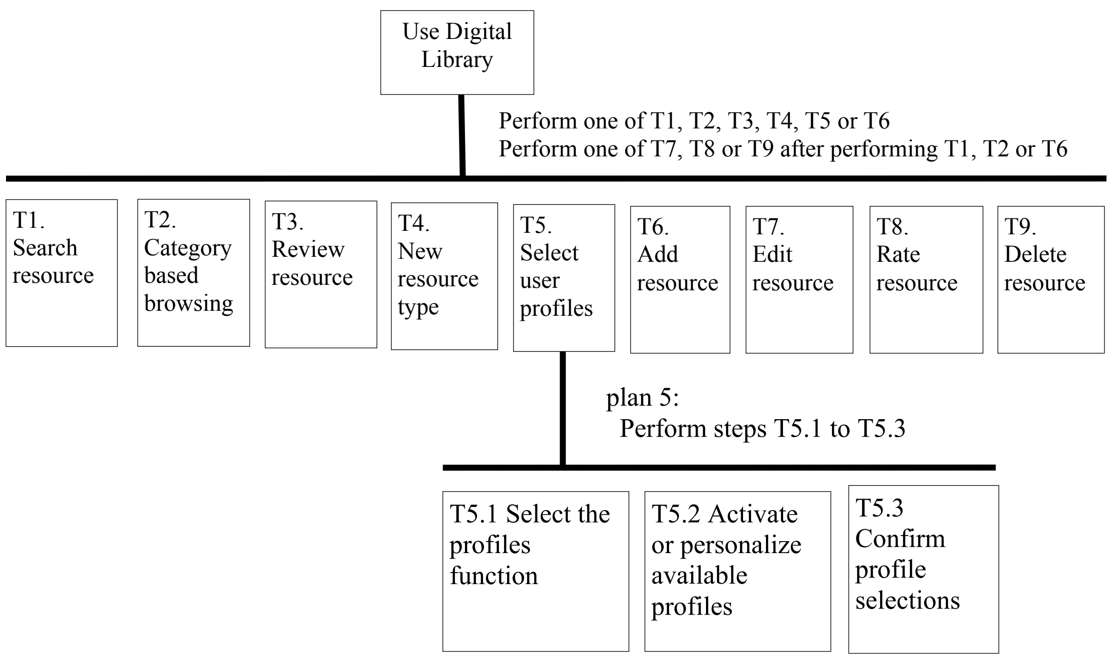


Figure 5:6: Task T5: Select user profiles

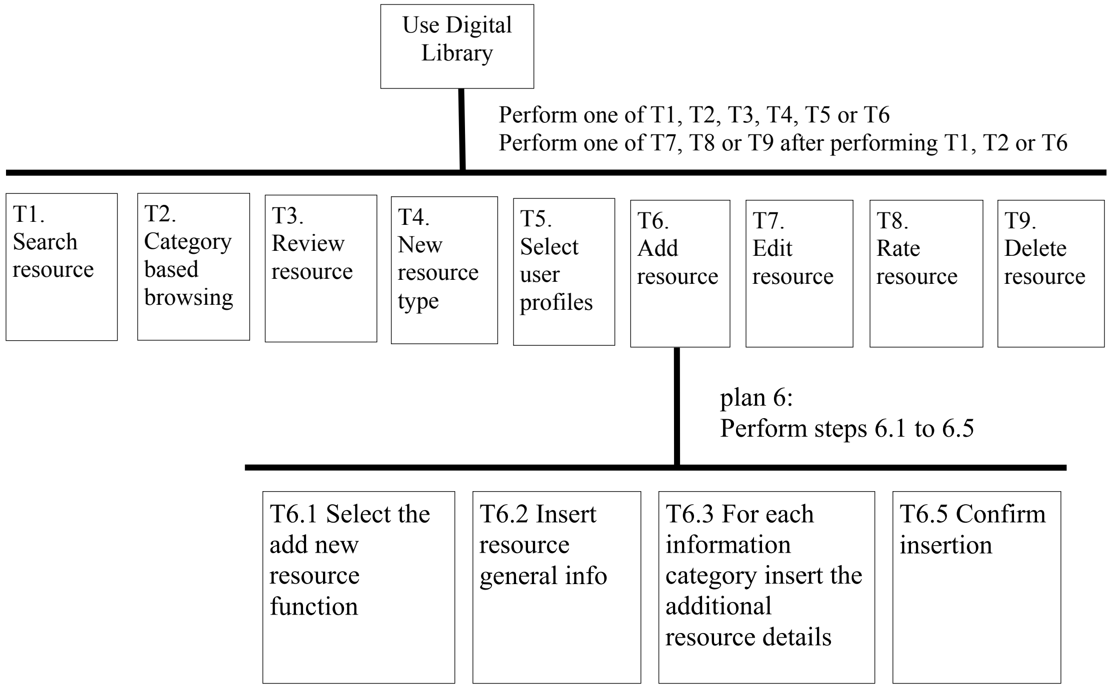


Figure 5:7: Task T6: Add resource

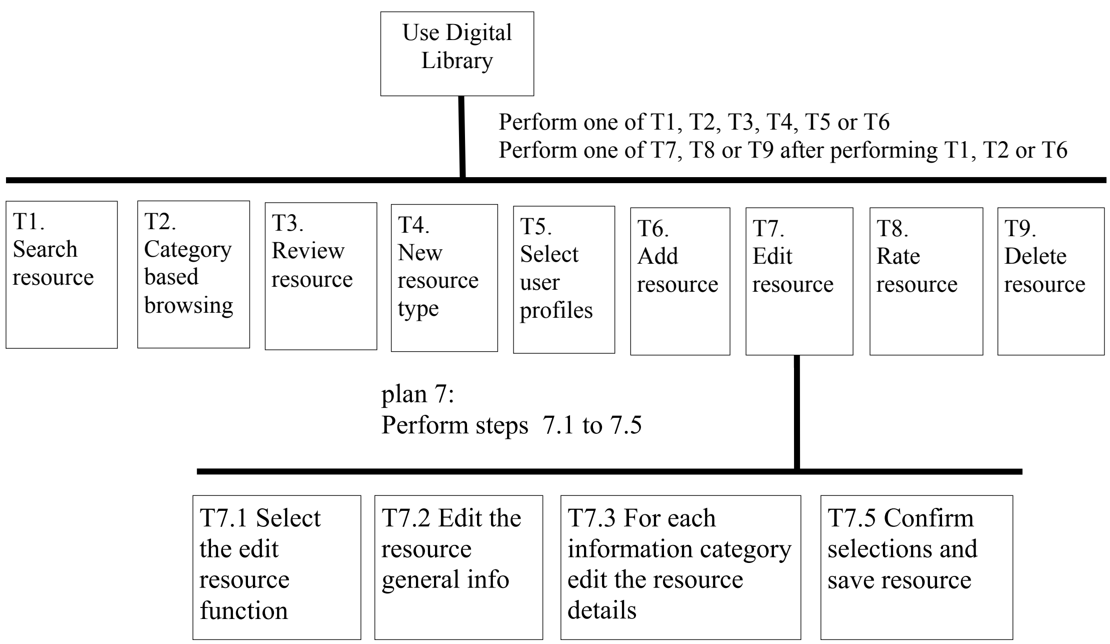


Figure 5:8: Task T7: Edit resource

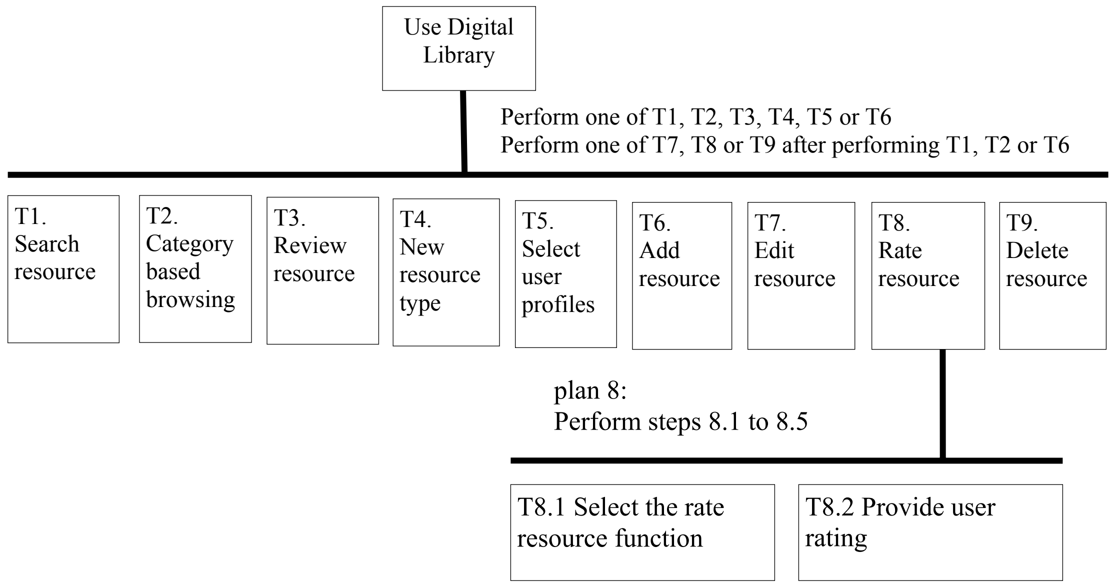


Figure 5:9: Task T8: Rate resource

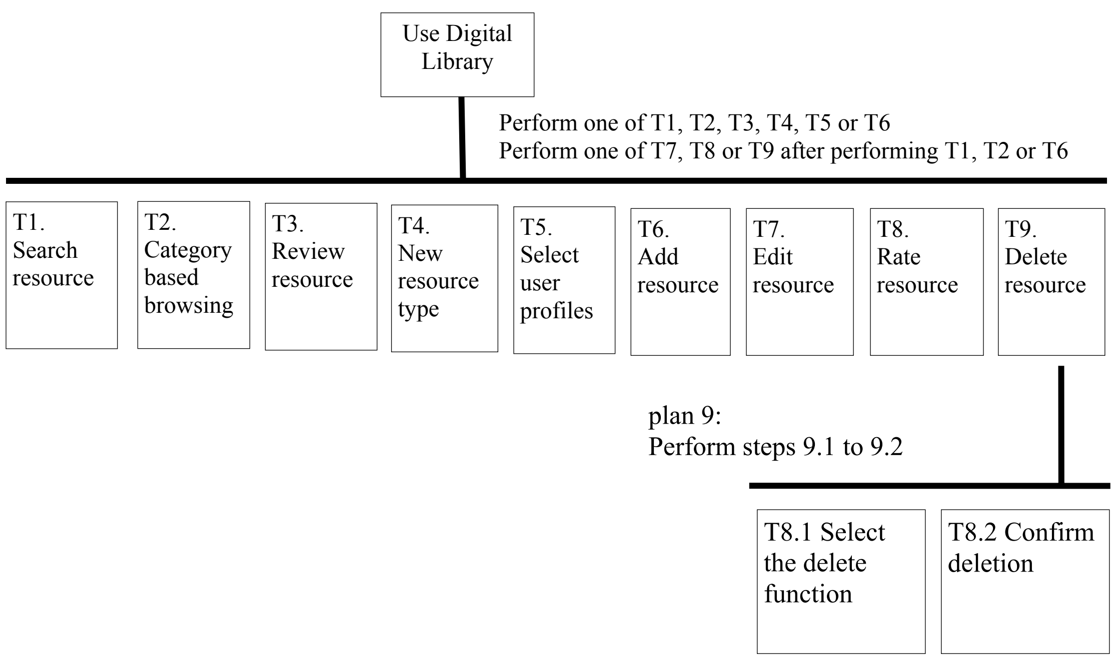


Figure 5:10: Task T9: Delete resource

5.4.2 Brainstorming sessions

User tasks identified

- T1. Use the message board facility
- T2. Use the chat facility

- T3. Use the documents area facility
- T4. Close session
- T5. Edit session details
- T6. View session details

Table 5:2 displays the mapping of the aforementioned user tasks to user roles.

Brainstorming Sessions		
User Category	**User role**	**User Tasks**
Knowledge end-users		-
Knowledge administrators		-
System administrators		-
Knowledge development key stakeholders	Working Group Members (WGMs)	T1, T2, T3, T6
	Working Group Leader (WGL)	T1, T2, T3, T4, T5, T6
	Originator	-
	Editor	-
	Authors	-
	Board of Executives (BoE)	T1, T2, T3, T6
	External Experts (ExEs)	T1, T2, T3, T6
	Interested Parties (IPs)	T1, T2, T3, T6
	Focal Points (FPs)	T1, T2, T3, T6
	Guidelines & Standardisation Experts (GSEs)	T1, T2, T3, T6

Table 5:2: Mapping of user tasks to user roles for Brainstorming sessions

The hierarchical analysis of the task identified above is schematically represented in Figure 5:11 to Figure 5:16 .

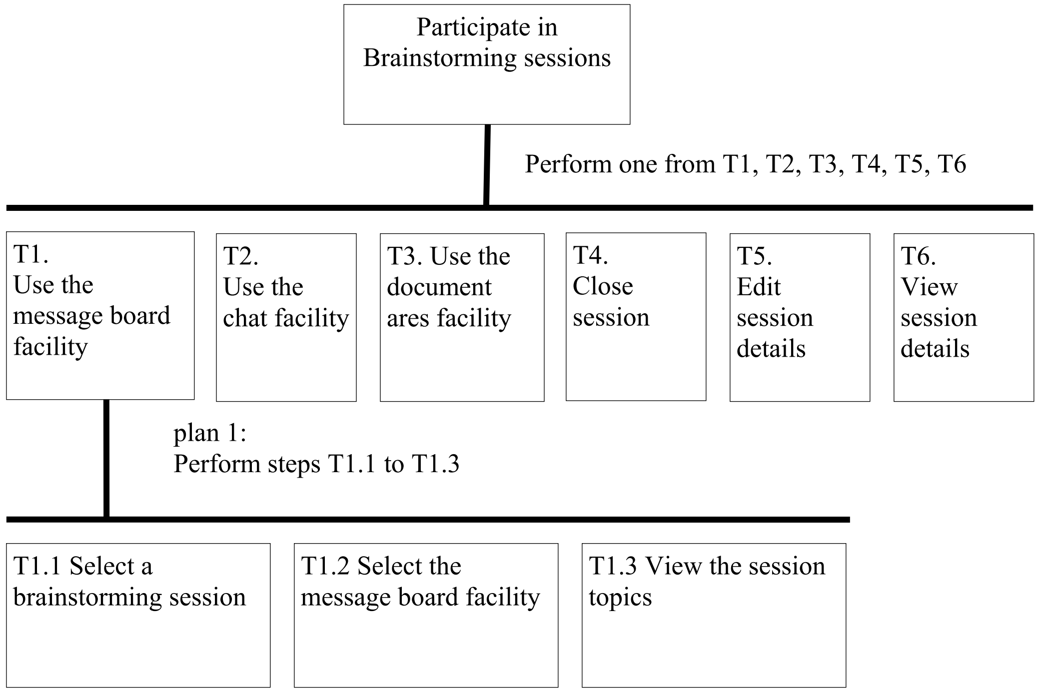


Figure 5:11: Task T1: Use the message board facility

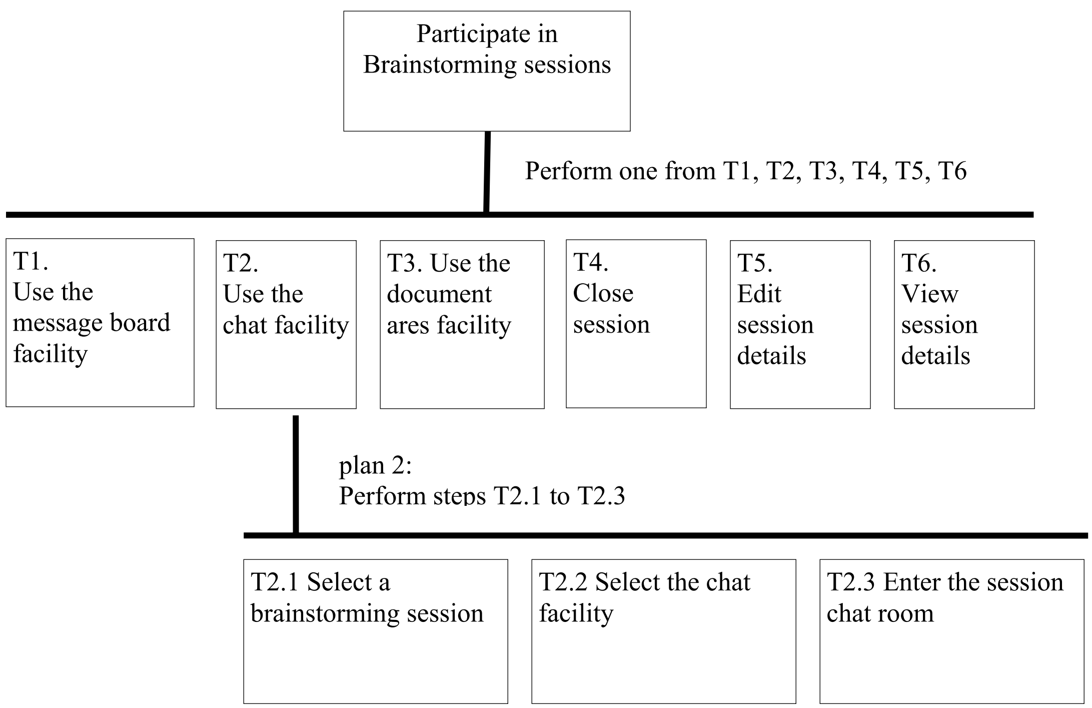


Figure 5:12: Task T2: Use the chat facility

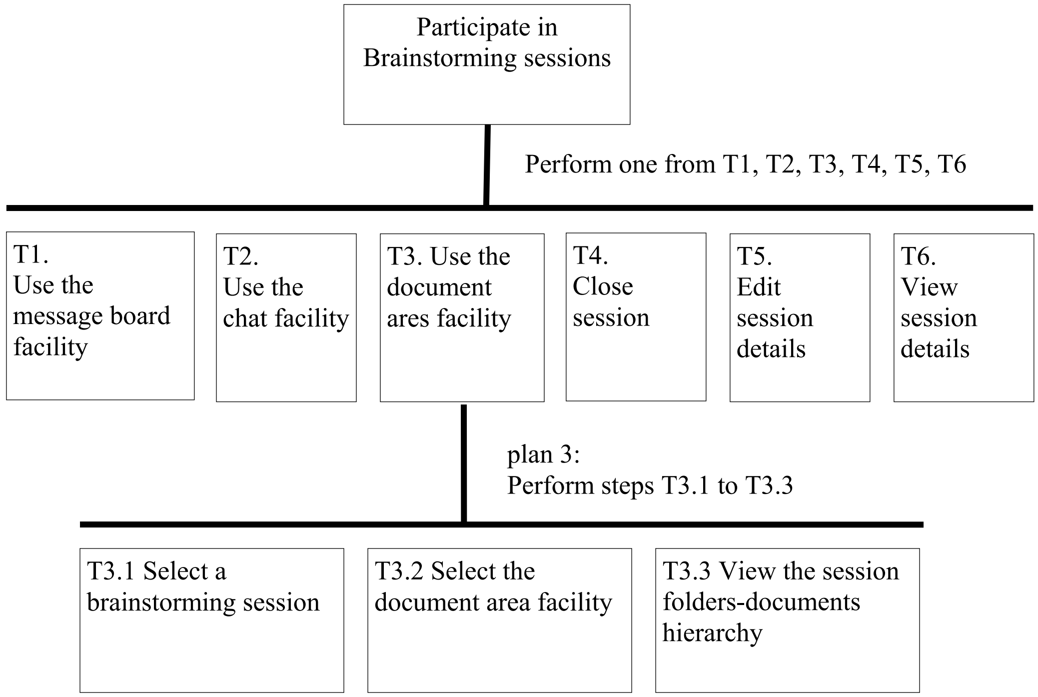


Figure 5:13: Task T3: Use the documents area facility

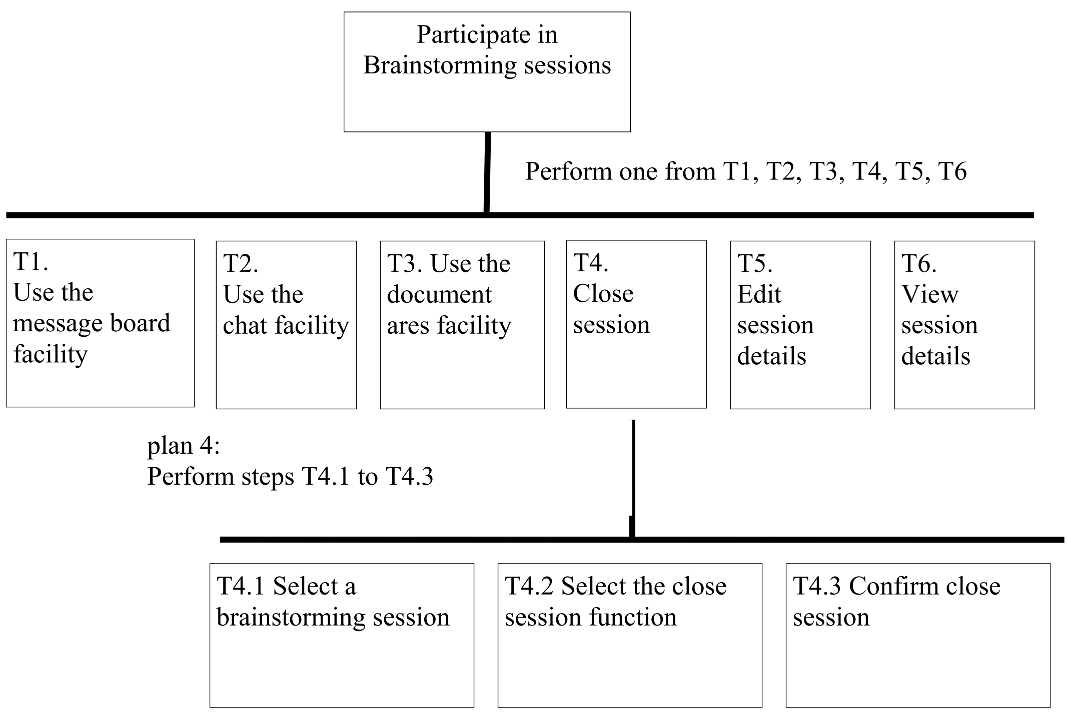


Figure 5:14: Task T4: Close session

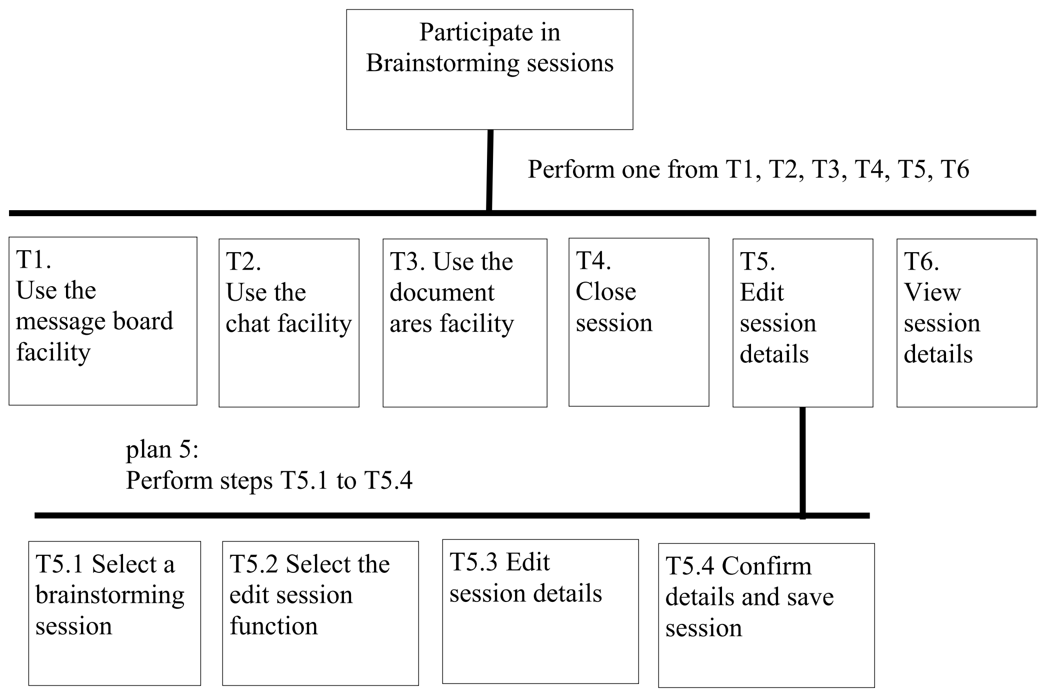


Figure 5:15: Task T5: Edit session details

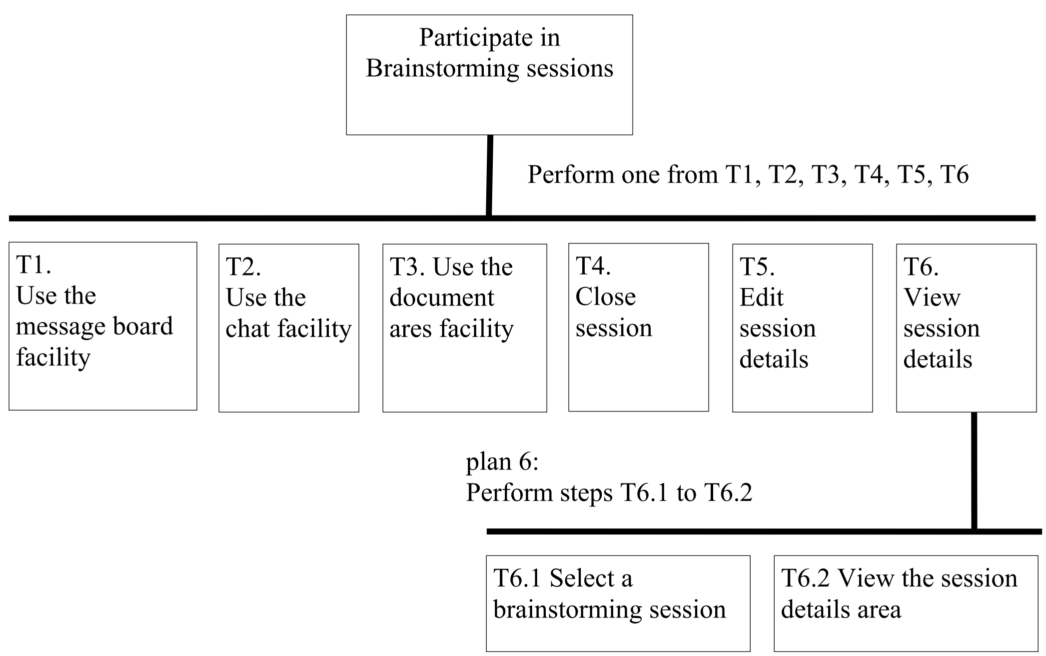


Figure 5:16: Task T6: View session details

5.4.3 Proposals

User tasks identified

- T1. Access proposal stages
- T2. View proposal document view
- T3. Use the message board facility
- T4. Use the chat facility
- T5. Use the document area facility
- T6.View proposal contributors
- T7. Edit proposal details
- T8. Withdraw proposal
- T9. View proposal details

Table 5:3 displays the mapping of the aforementioned user tasks to user roles.

Proposals		
User Category	**User role**	**User Tasks**
Knowledge end-users		-
Knowledge administrators		-
System administrators		-
Knowledge development key stakeholders	Working Group Members (WGMs)	T1, T2, T3, T4, T5, T6, T9
	Working Group Leader (WGL)	T1, T2, T3, T4, T5, T6, T9
	Originator	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
	Editor	-
	Authors	-
	Board of Executives (BoE)	T1, T2, T3, T4, T5, T6, T9
	External Experts (ExEs)	T1, T2, T3, T4, T5, T6, T9
	Interested Parties (IPs)	T1, T2, T3, T4, T5, T6, T9
	Focal Points (FPs)	T1, T2, T3, T4, T5, T6, T9
	Guidelines & Standardisation Experts (GSEs)	T1, T2, T3, T4, T5, T6, T9

Table 5:3: Mapping of user tasks to user roles for Proposals

The hierarchical analysis of the task identified above is schematically represented in Figure 5:17 to Figure 5:25.

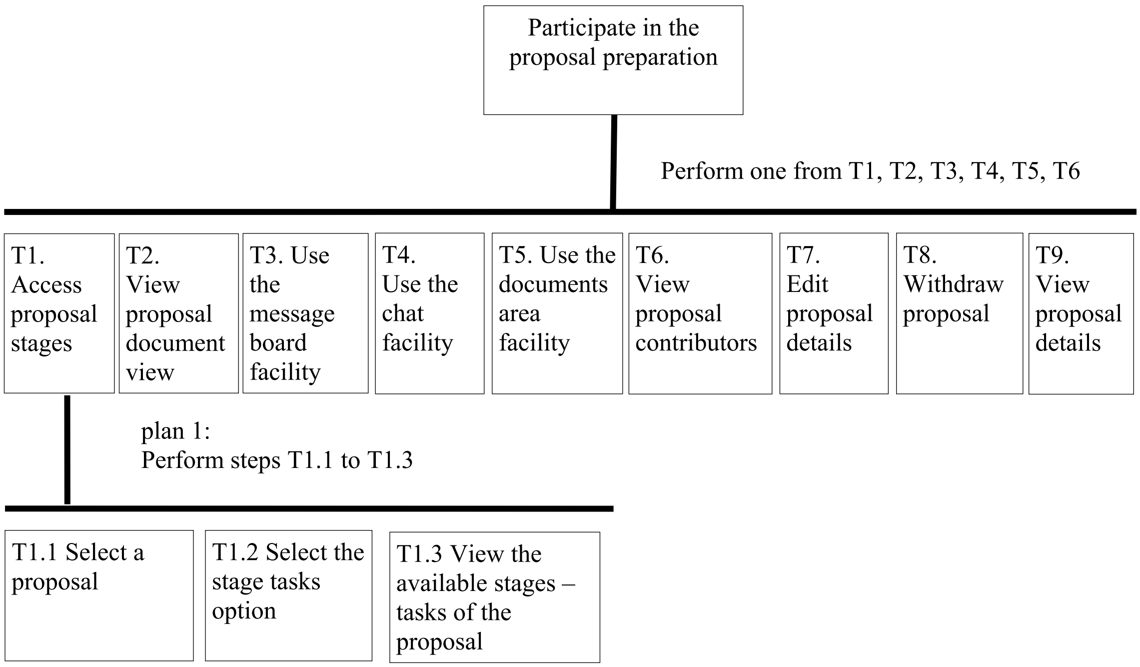


Figure 5:17: Task T1: Access proposal stages

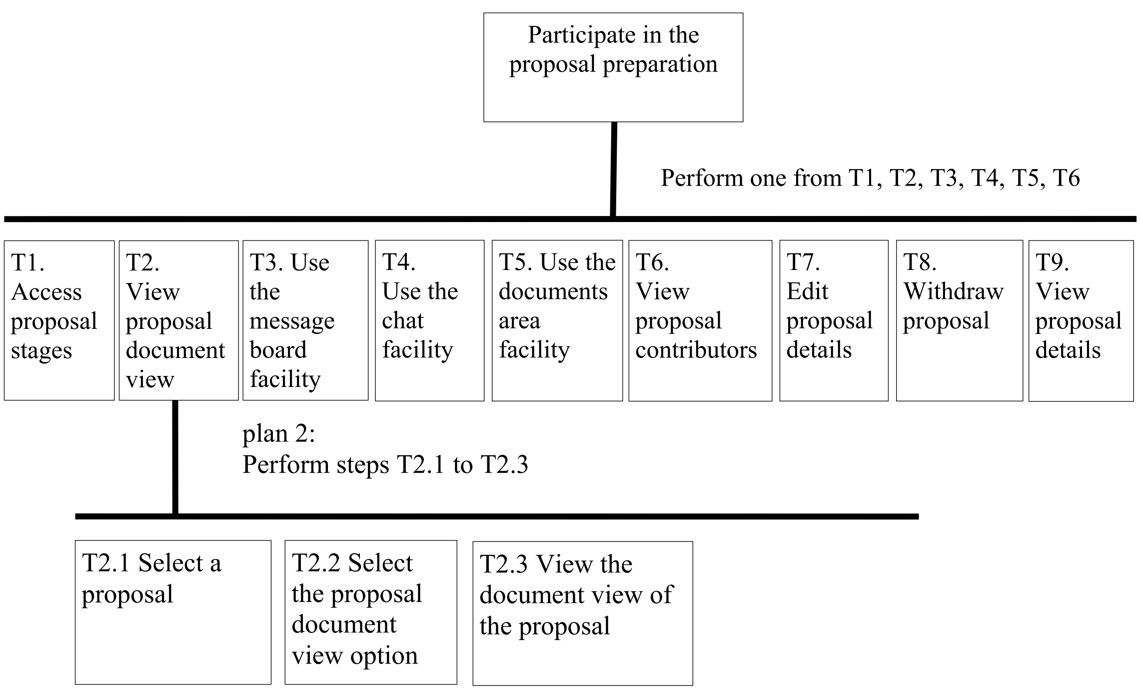


Figure 5:18: Task T2: View proposal document view

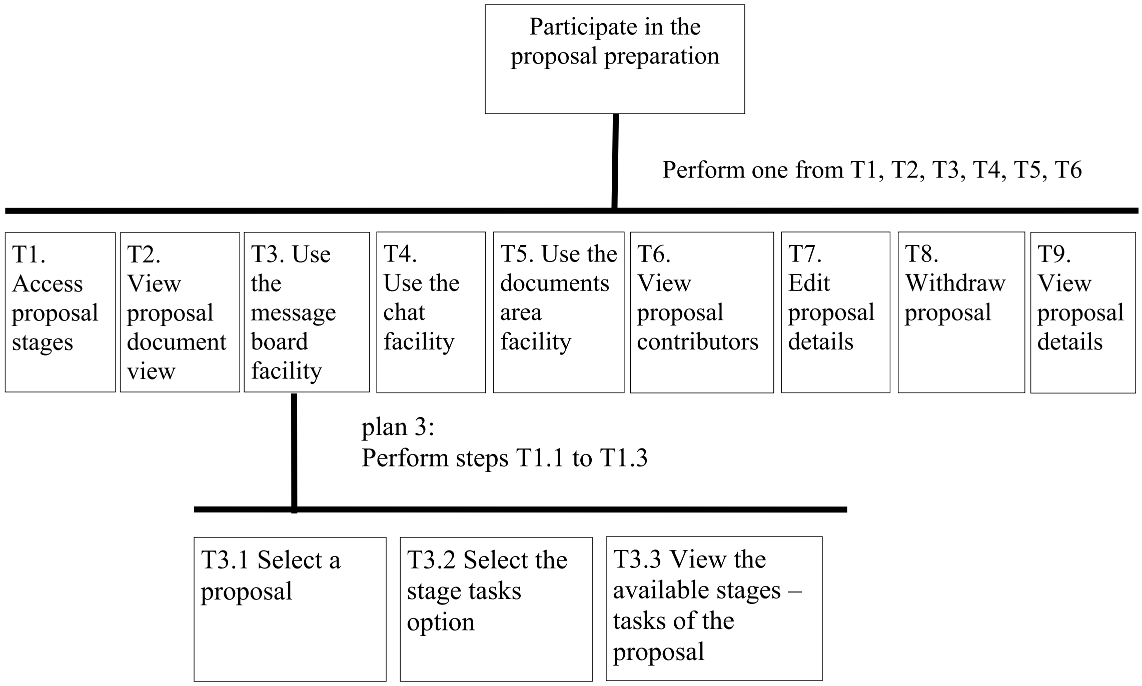


Figure 5:19: Task T3: Use the message board facility

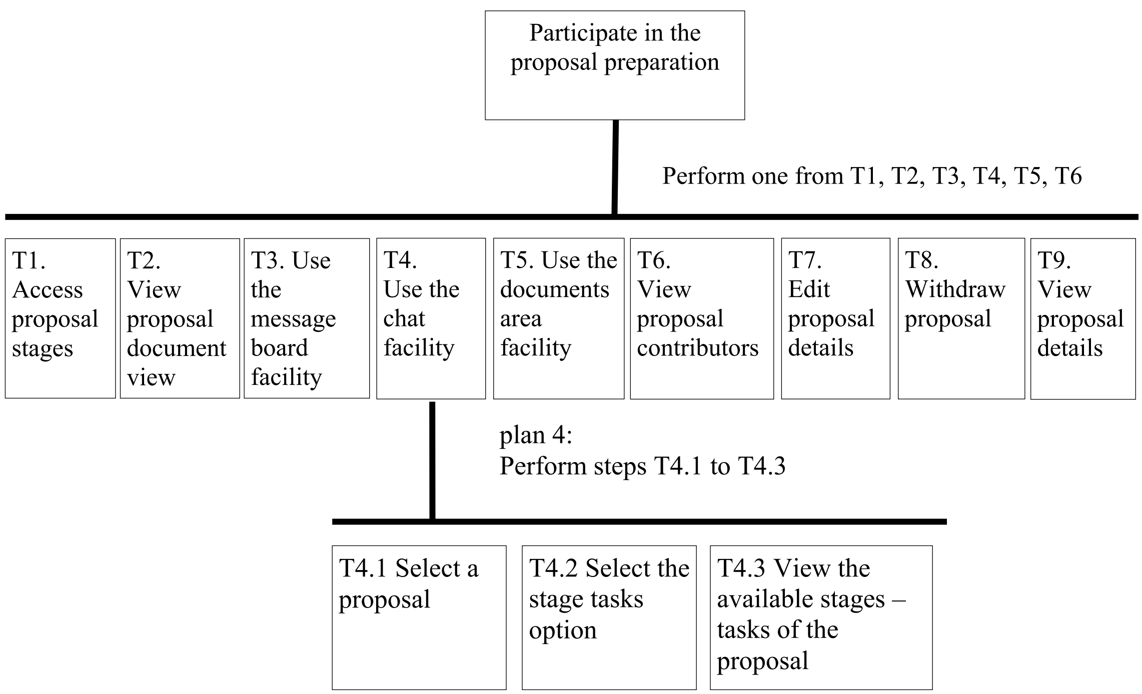


Figure 5:20: Task T4: Use the chat facility

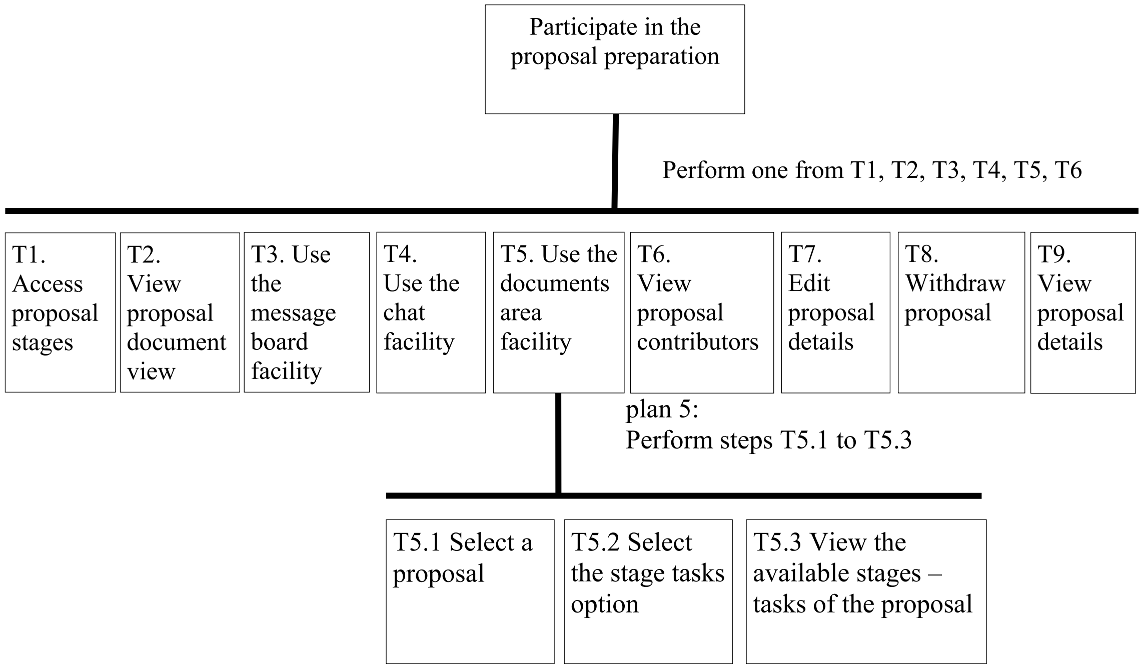


Figure 5:21: Task T5: Use documents area facility

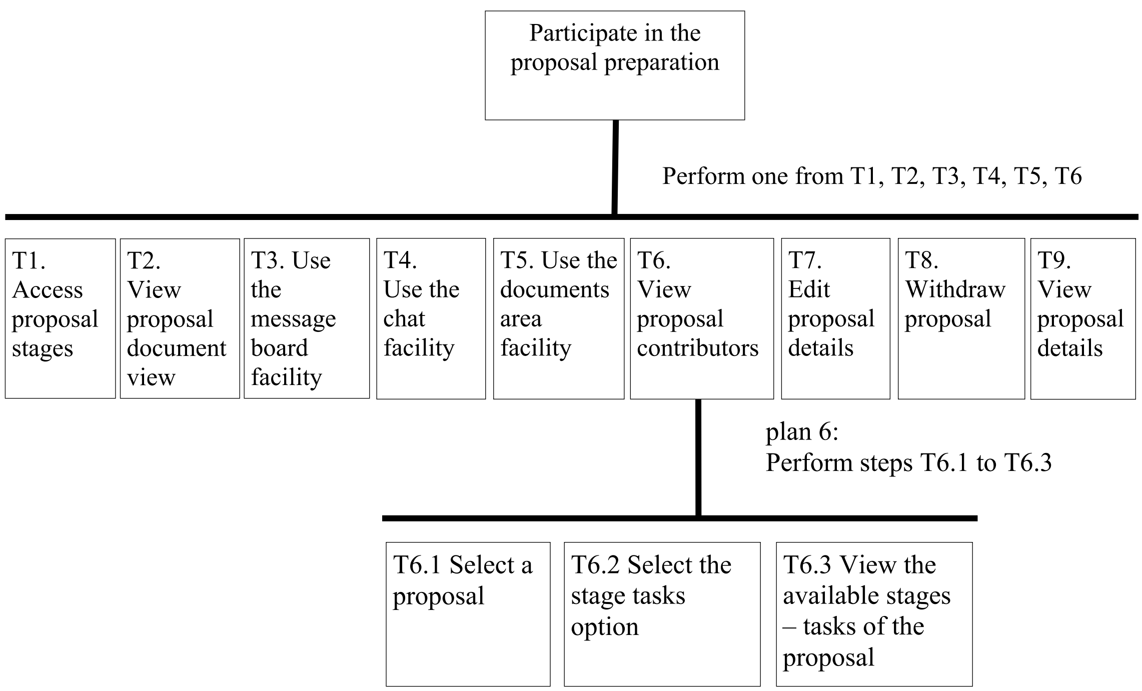


Figure 5:22: Task T6: View proposal contributors

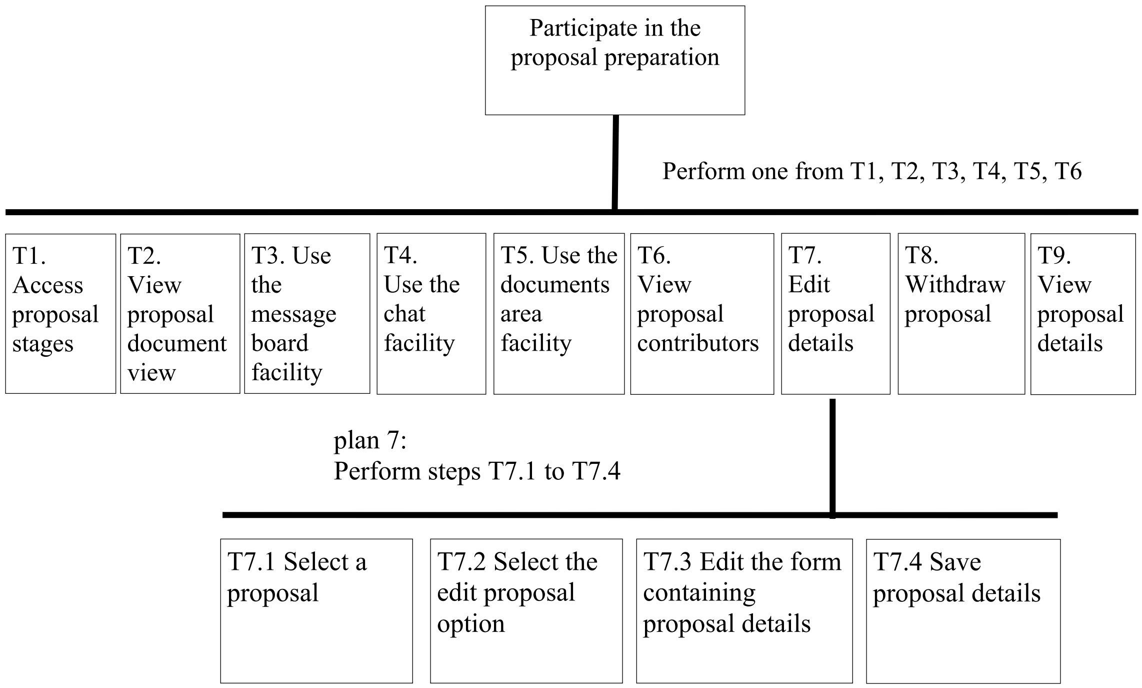


Figure 5:23: Task T7: Edit proposal details

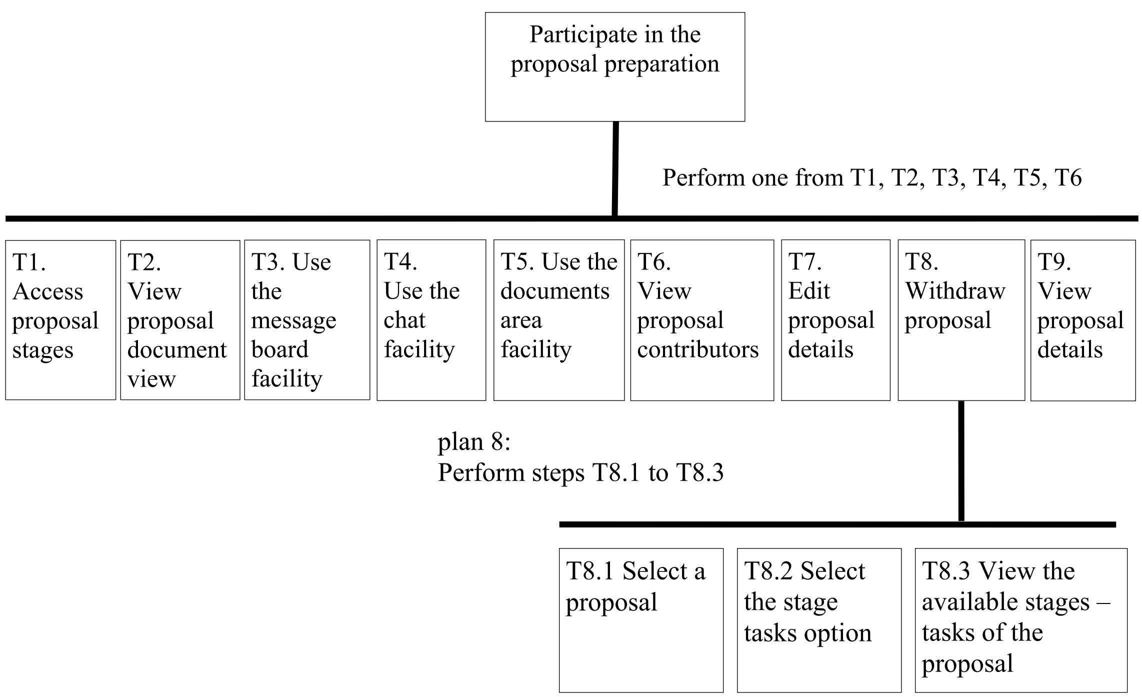


Figure 5:24: Task T8: Withdraw proposal

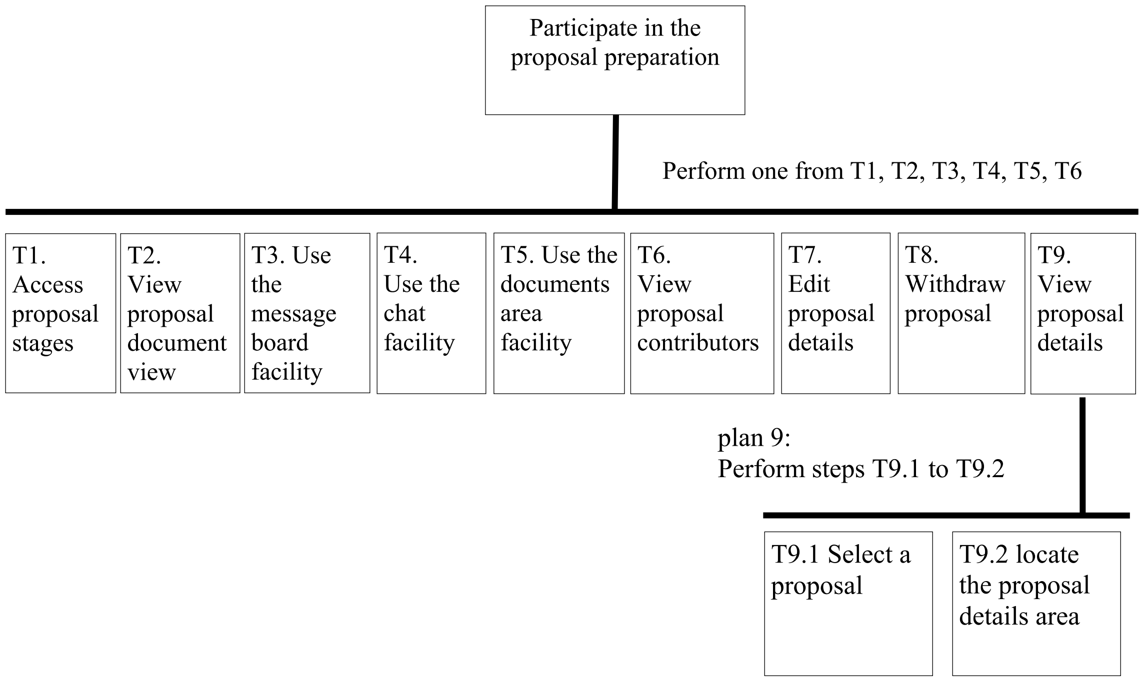


Figure 5:25: Task T9: View proposal details

5.4.4 Projects

User tasks identified

- T1. Access project stages
- T2. View project document view
- T3. View project resources view
- T4. Use the message board facility
- T5. Use the chat facility
- T6. Use the document area facility
- T7. View project contributors
- T8. Edit project details
- T9. Withdraw project
- T10. View project details

Table 5:4 displays the mapping of the aforementioned user tasks to user roles.

Digital Library		
User Category	**User role**	**User Tasks**
Knowledge end-users		-
Knowledge administrators		-
System administrators		-

Knowledge development key stakeholders	Working Group Members (WGMs)	T1, T2, T3, T4, T5, T6, T7, T10
	Working Group Leader (WGL)	T1, T2, T3, T4, T5, T6, T7, T10
	Originator	-
	Editor	T1, T2, T3, T4, T5, T6, T7, T8, T9, T10
	Authors	T1, T2, T3, T4, T5, T6, T7, T10
	Board of Executives (BoE)	T1, T2, T3, T4, T5, T6, T7, T10
	External Experts (ExEs)	T1, T2, T3, T4, T5, T6, T7, T10
	Interested Parties (IPs)	T1, T2, T3, T4, T5, T6, T7, T10
	Focal Points (FPs)	T1, T2, T3, T4, T5, T6, T7, T10
	Guidelines & Standardisation Experts (GSEs)	T1, T2, T3, T4, T5, T6, T7, T10

Table 5:4: Mapping of user tasks to user roles for Projects

The hierarchical analysis of the task identified above is schematically represented in Figure 5:26 to Figure 5:35.

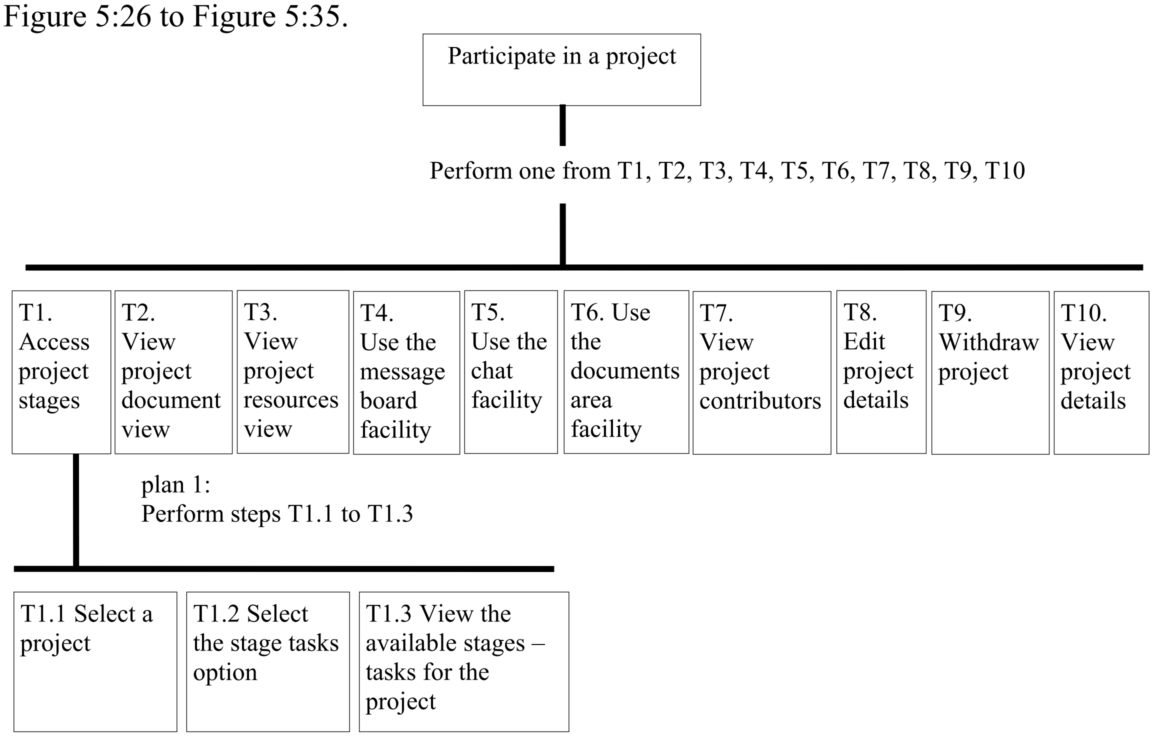


Figure 5:26: Task T1: Access project stages

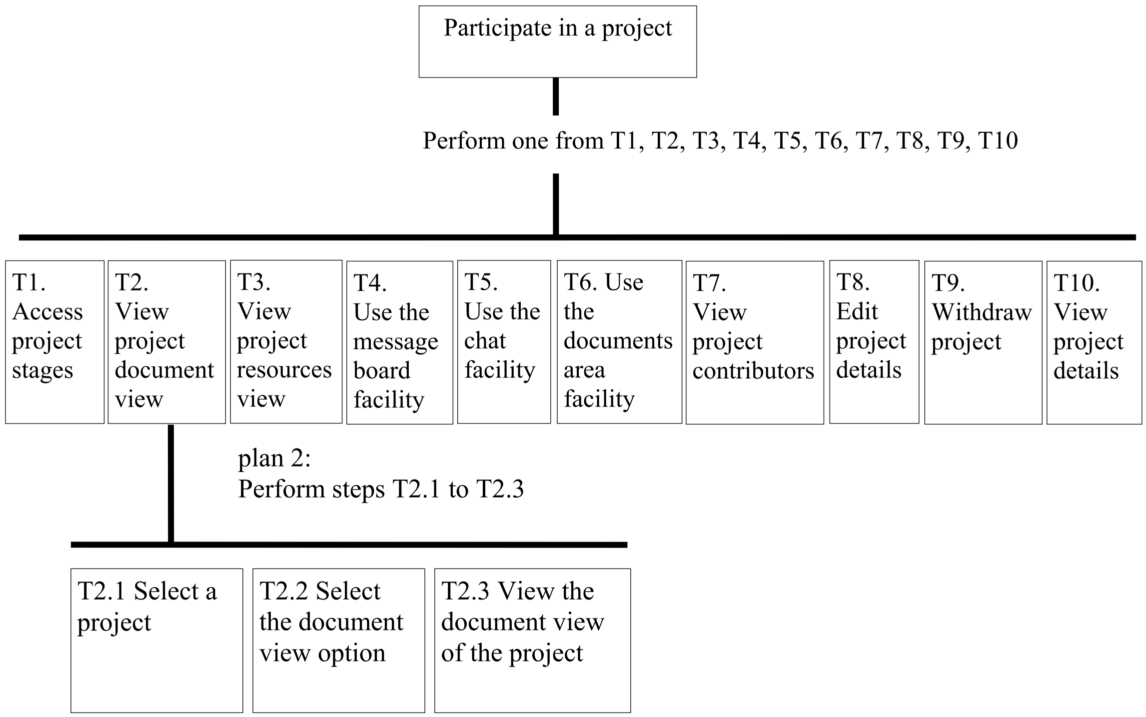


Figure 5:27: Task T2: View project document view

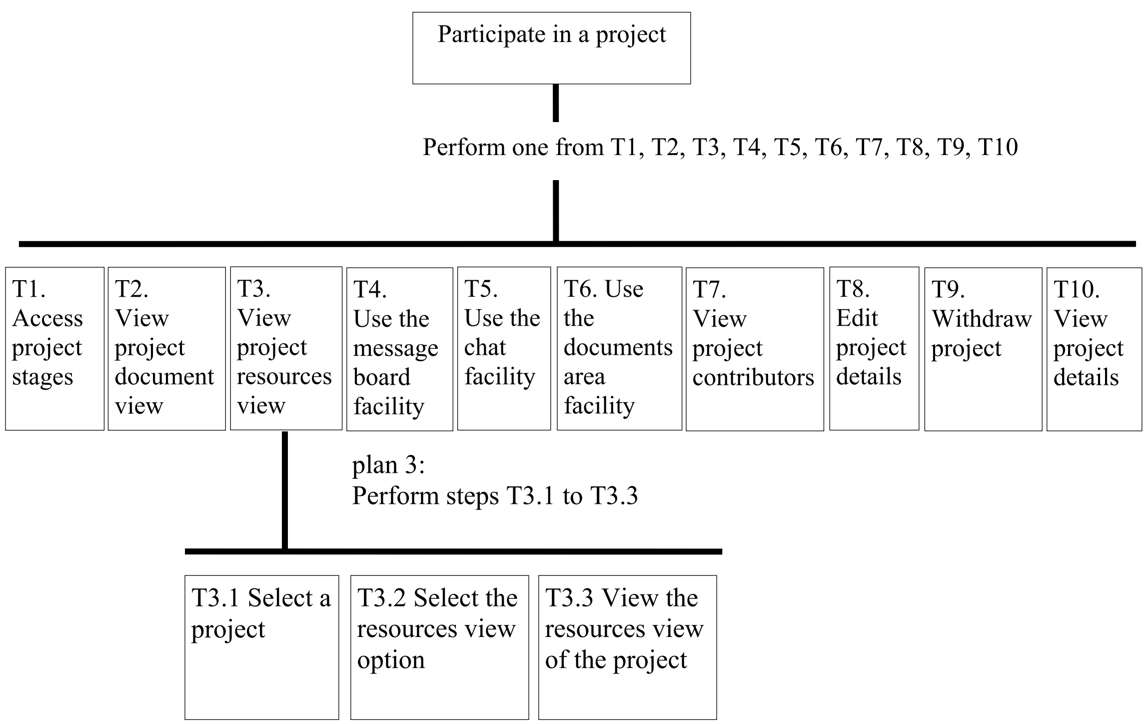


Figure 5:28: Task T3: View project resources view

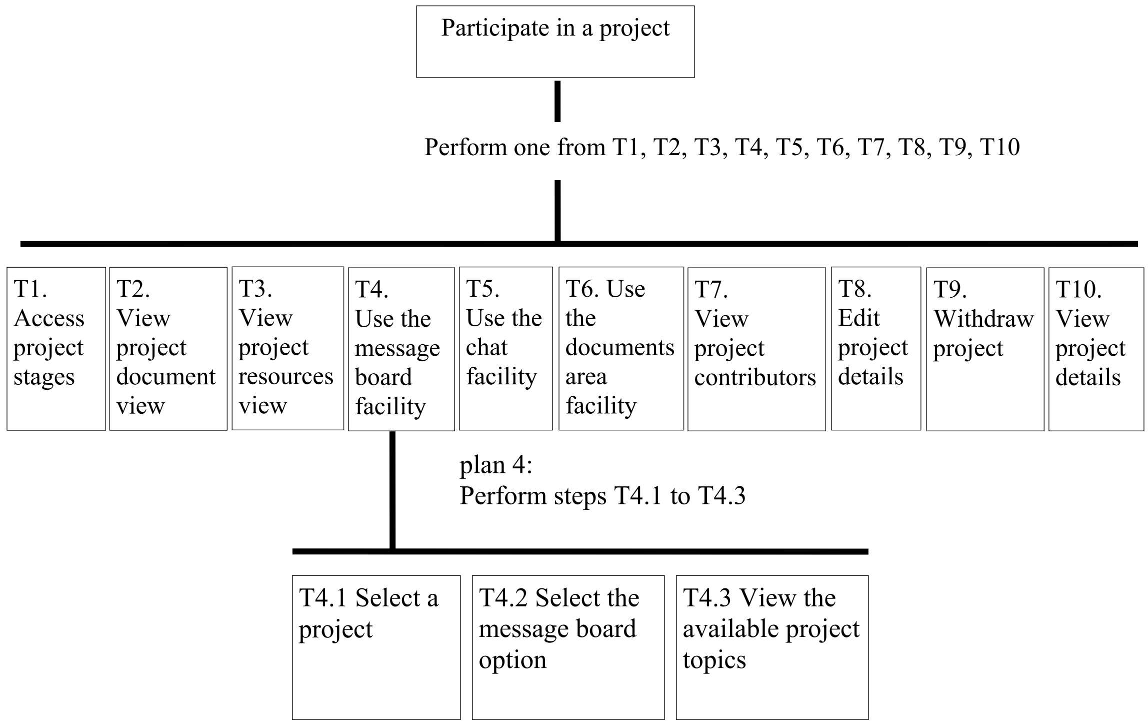


Figure 5:29: Task T4: Use the message board facility

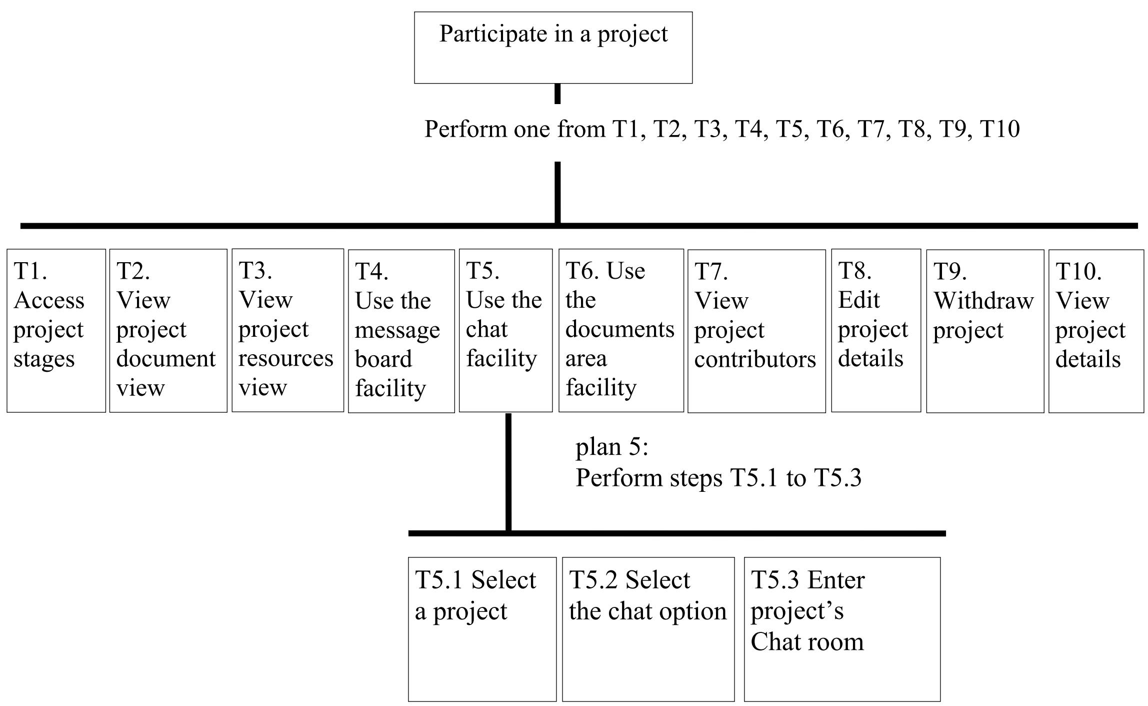


Figure 5:30: Task T5: Use chat facility

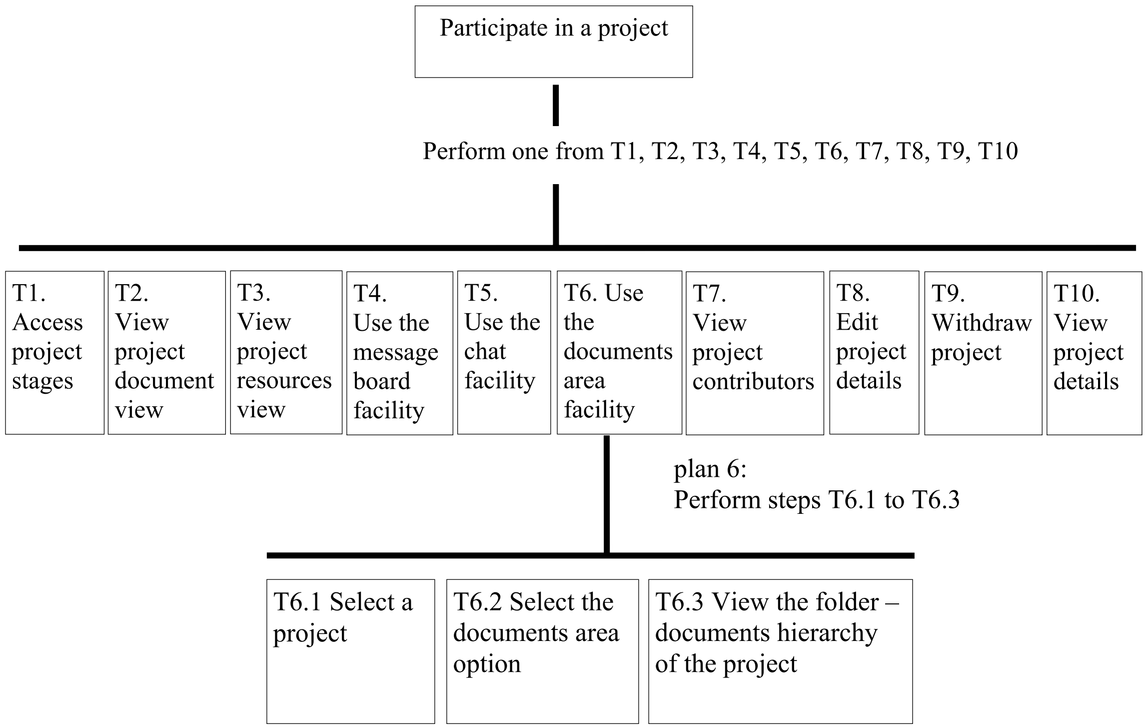


Figure 5:31: Task T6: Use the documents area facility

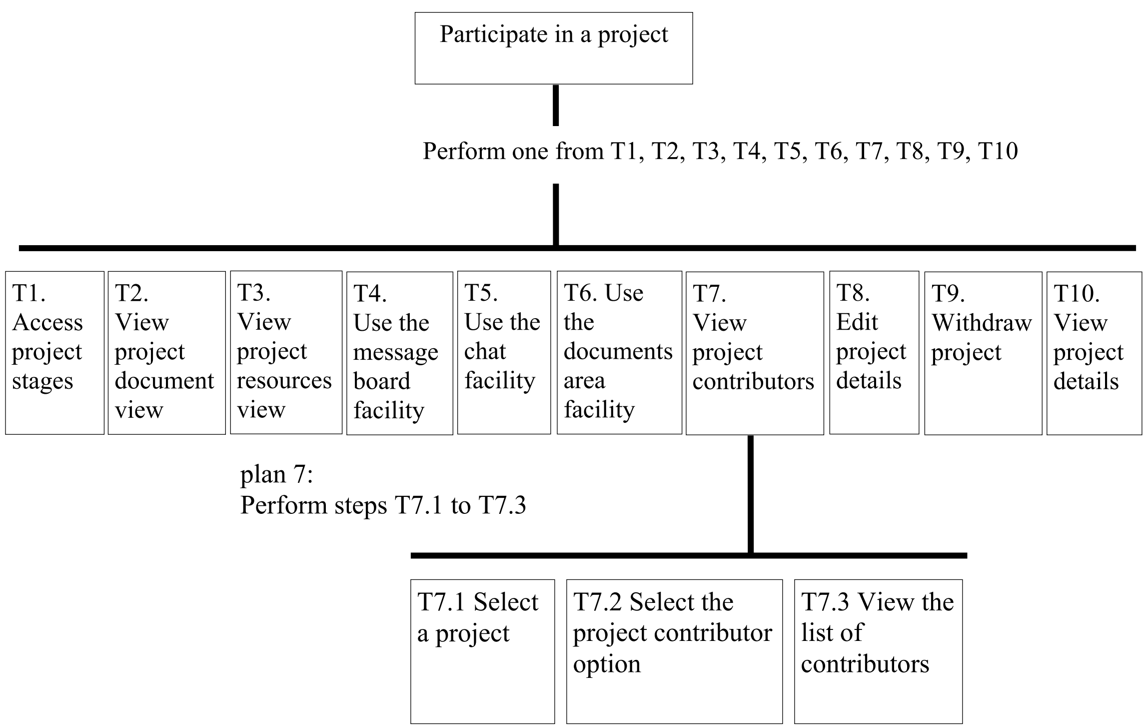


Figure 5:32: Task T7: View project contributors

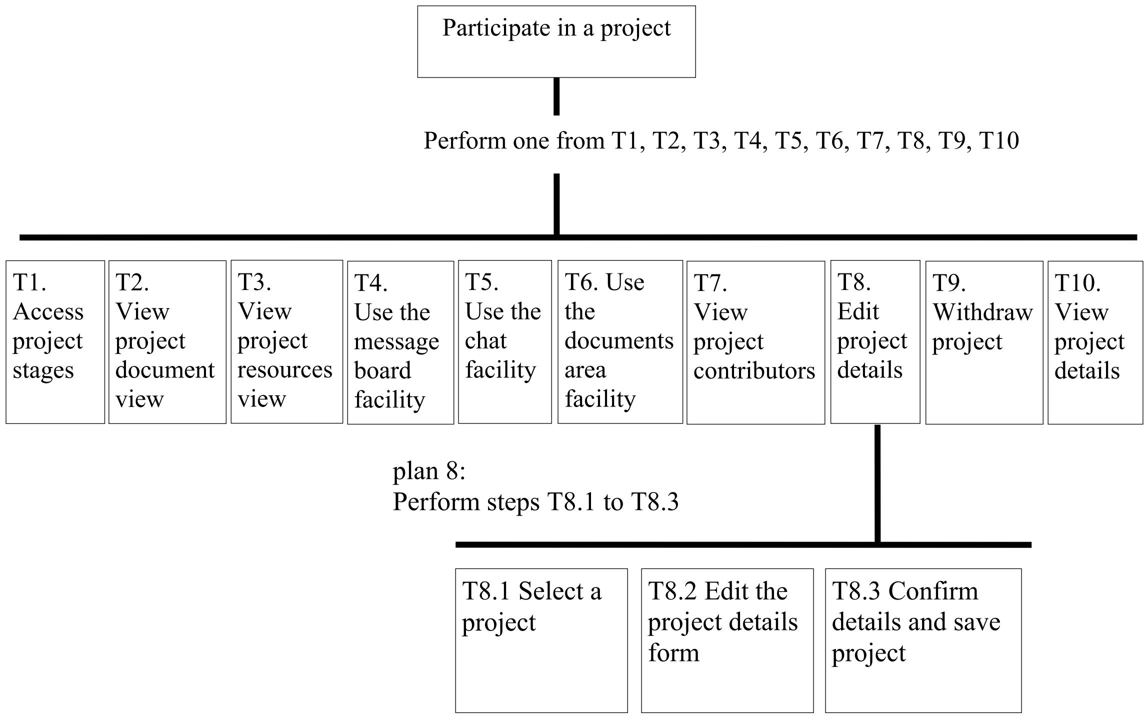


Figure 5:33: Task T8: Edit project details

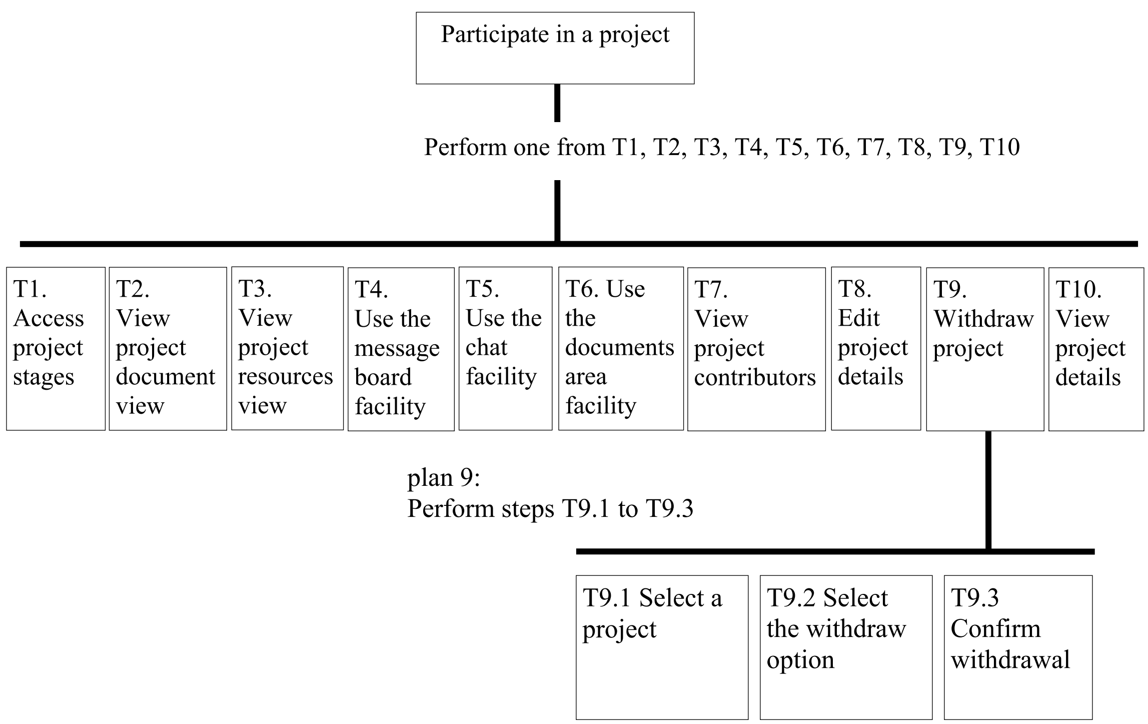


Figure 5:34: Task T9: Withdraw project

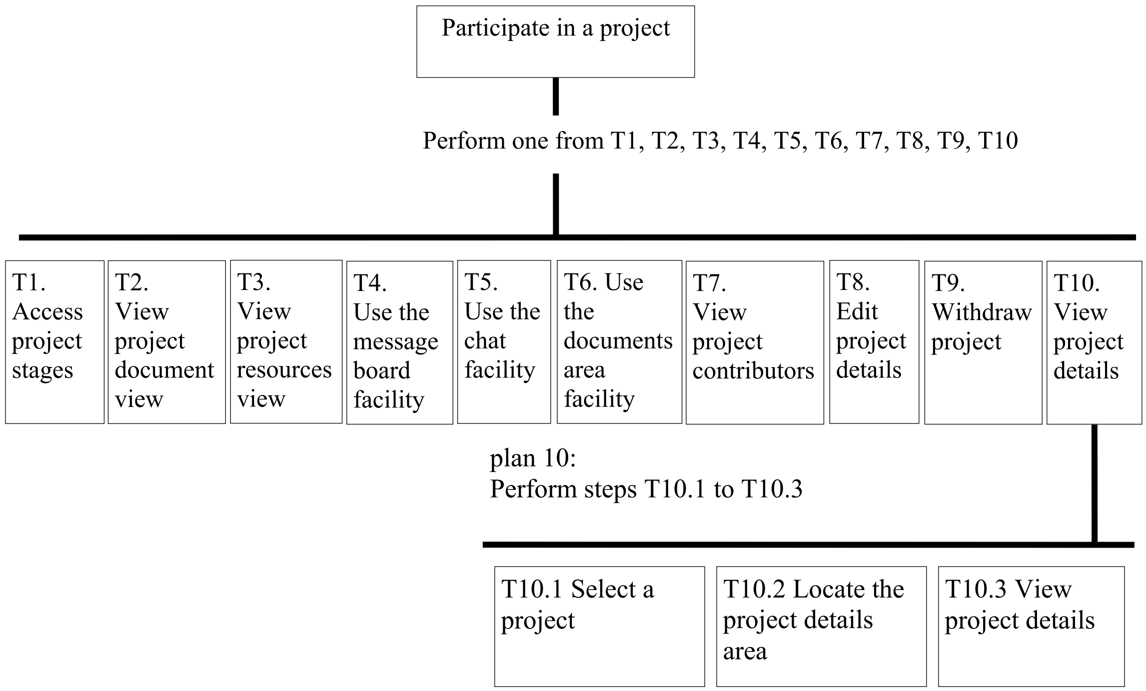


Figure 5:35: Task T10: View project details

5.5 User Interface Design

For the design of the user interface of Pages for VR several sources of human-computer interaction guidelines were studied, including the Nielsen set of guidelines (Molich and Nielsen, 1990 and Nielsen, 1994b) and Shneiderman's eight golden rules of interface design (Shneiderman, 1987). Furthermore, a collection of one hundred and thirteen guidelines for ensuring homepage usability, published by Nielsen and Tahir, were thoroughly analysed, taking into account all the design issues mentioned (Nielsen and Tahir, 2001).

Usually, user interface design initiates with the production of low-fidelity prototypes and continues with higher-fidelity prototypes. The use of prototypes in the design phase aims at allowing the designers to test some emerging ideas for the design in question. While evaluating a prototype, the designers can identify functional requirements, usability problems and performance issues that can be dealt with at once and before the implementation phase (Beaudouin-Lafon and Mackay, 2003 and Preece et al., 2002). This approach was adopted in the user interface design of the Pages for VR system. The user interface design was completed by a series of low-fidelity prototypes that were evaluated. The analytical process was conducted through a number of iterations. Each iteration involved the creation of prototypes and the evaluation of these prototypes by usability expert and system end-users. Additionally, some basic principles that were taken into consideration in order to enhance the accessibility characteristics of the final product are summarised below[24]:

a) General

- Design and maintenance of a prototype that can be used in all web browsers.
- Page size must not exceed 800x600 pixels of a PC screen.

b) Development of an accessible interface

- All available information presented must be displayed, regardless of the web browser, PC screen or operating system used to display them.
- The use of HTML tags that are recognized only by specific web browsers should be avoided.
- Style sheets should be used throughout.
- The use of black fonts in white background makes a page easy to read.
- Simple descriptions of file content, size and type must be provided for all files available for download.
- Meta-tags should be used.
- The use of active images, flash-type graphics etc should be avoided.
- Alternative text should be used for all objects that are presented in the screen, so that there is available information to be used by screen readers.
- All information conveyed with colour should be also available without colour.
- The use of tables should be avoided.

c) Navigation

- Navigation and content structure must be coherent throughout the web site.

[24] Web Content Accessibility Guidelines 1.0 of the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C), see: http://www.w3c.org/WAI

- Links used for navigation must be placed on the left hand side of a page, as in most available web sites.
- A link to the home page must be available in all pages of the site
- A link for general information regarding the web site must be provided
- A link with contact information about the administrators of the web site must be provided
- Links and objects appearing on a web site must be organized coherently

d) Content presentation

- Content must be clearly distinguished from the artistic presentation of the web page so that users can easily choose the page appearance according to the preferred style sheet.

5.5.1 First iteration of the user interface design

The design of the system entailed the creation of various design sketches. The first page of the web application, containing the necessary functionality, was initially created as shown in Figure 5:36. An area for user registration and login was provided on the left side of the screen, accompanied with the option to test the system using the default user models. Additionally, in the central part of the screen, information about the system was presented. Finally the right side of the screen was used in order to offer additional facilities such as news, statistics and tips.

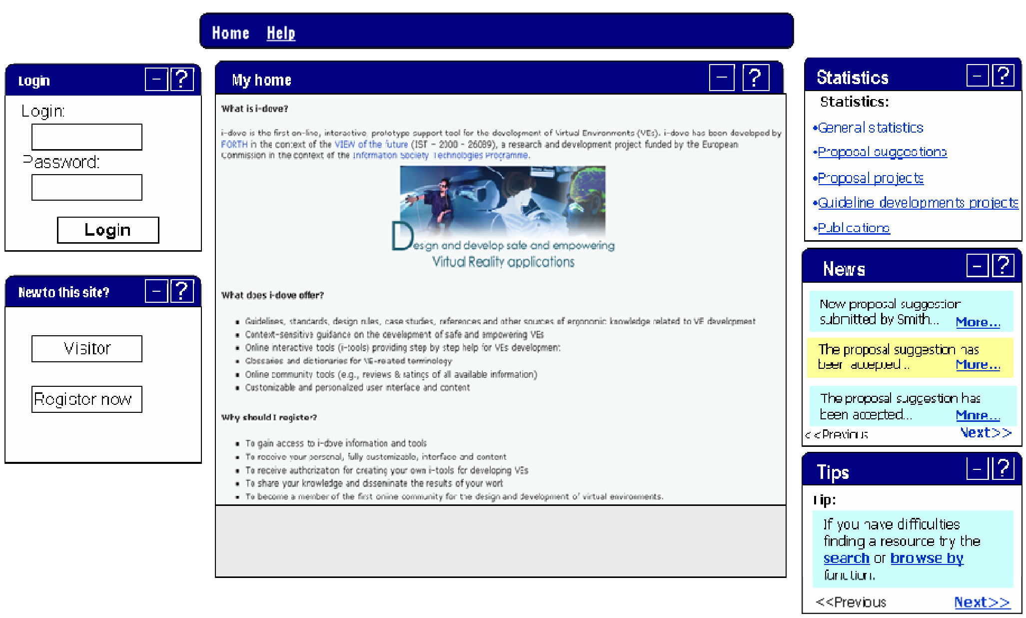


Figure 5:36: The first low-fidelity prototype of the portal home page

Along with the design of the system initial page, the first design of the registered users' area was made. In this phase, prototypes were developed only for the basic user categories identified by user requirements analysis:

- Knowledge consumers
- Knowledge developers

Regarding knowledge consumers, the first prototype is presented in Figure 5:37.

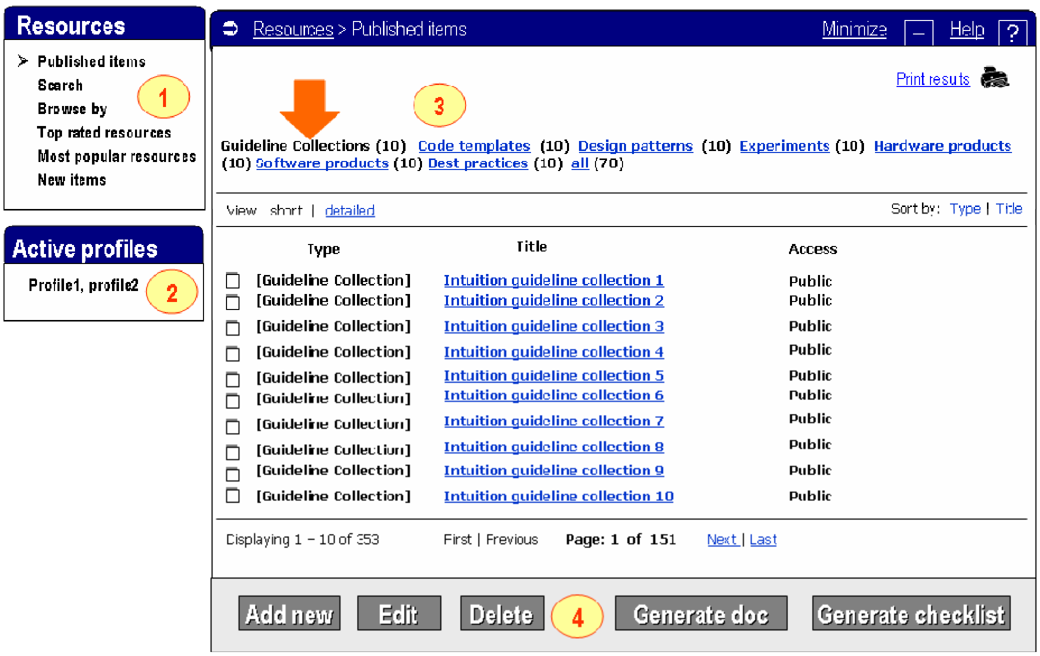


Figure 5:37: The first prototype of the knowledge consumers' site

The main areas of this page are:

1. **Resources:** This area contains functionality for category based browsing of resources, search facility, social navigation (top rated, most popular resources) and browsing of most recent items.
2. **Profiles:** Contains the activated knowledge profiles for results filtering.
3. **Browsing based on resource types:** Tab based presentation of resource types that enable quick access to resources of different types.
4. **Resource based options**: Contains the functions that can be performed on resources.

Figure 5:38 presents the first design of the knowledge developers' portal.

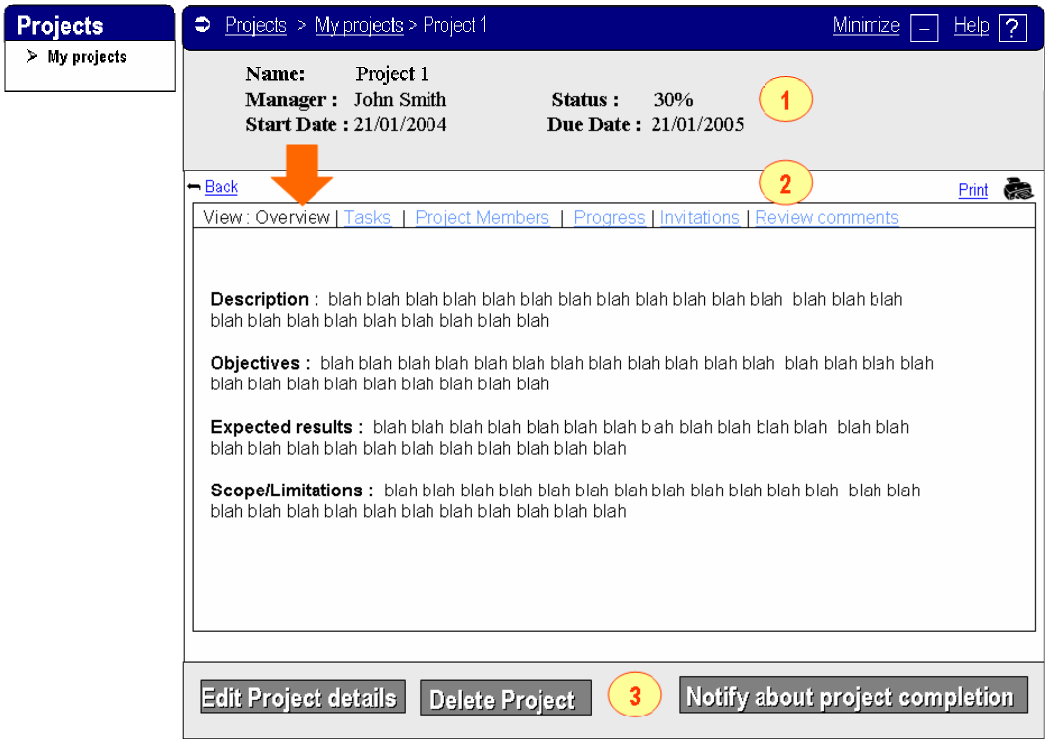


Figure 5:38: The first prototype of the knowledge developers' portal

The main areas in this page are:

1. **Project details:** Contains general information about the project such as name, person in charge, status etc.
2. **Project features:** Contains a tab based representation of the features provided by each project such as the tasks to be accomplished the contributors participating, its progress etc.
3. **Project based functions:** Contains the functions that can be performed for each project.

5.5.2 Second iteration of the user interface design

The second iteration commenced with the design of low-fidelity prototypes aiming at addressing comments made by the expert based evaluation of the initial design sketches. The comments made regarding the knowledge consumers' site were:

- The need to add personalisation facilities for end users in order to make the retrieval of knowledge more efficient.

- Individual resources should be contained into datasets of knowledge providing in that way access to resources upon subscription to datasets.
- Access to resources after subscription to collections.

Figure 5:39 present the second iteration of design regarding the knowledge consumers' layout and functionality.

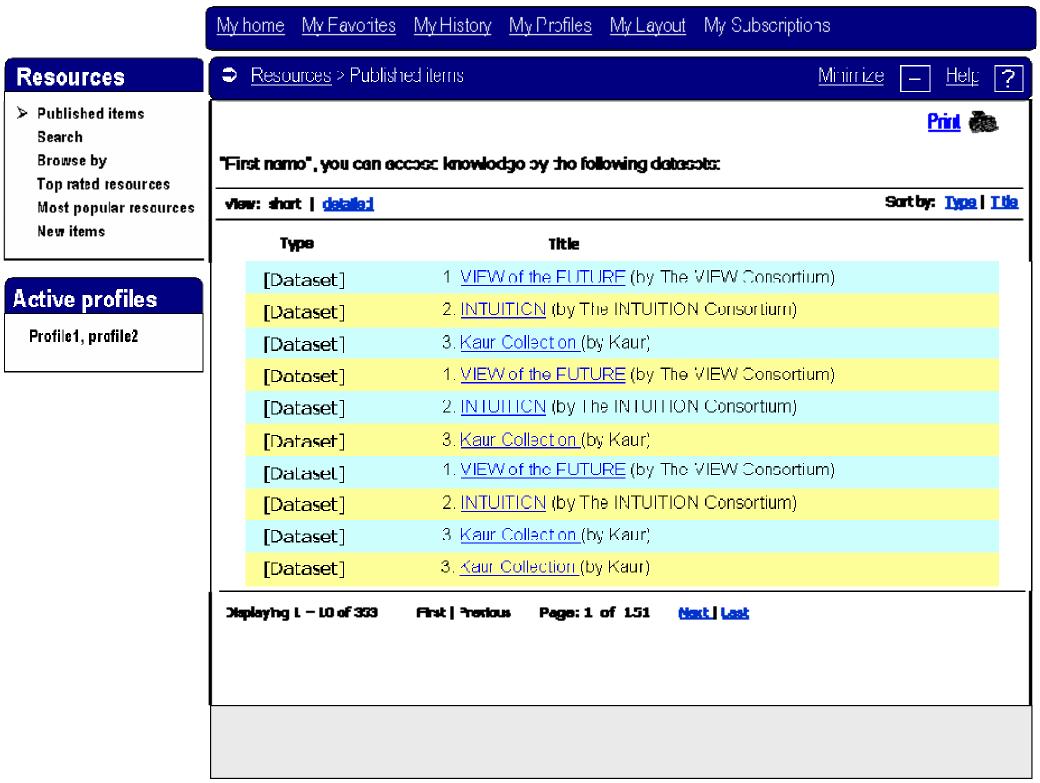


Figure 5:39: The second prototype of the knowledge consumers' site

A top navigation bar was added containing all user based facilities offered by the digital library. These facilities include:

- **Favourites:** Component that allows users to keep bookmarks to resources.
- **History:** A repository of resources browsed by each user of the system.
- **Profiles:** Facility that enables the administration (activation, deactivation) of user profiles.
- **Subscriptions:** Facility that can be used to post subscription request for knowledge collections.

Additionally, in the second prototype, the presentation format of the published resources has been changed and the resources are initially categorised in a number of datasets (knowledge collections). Complementary to the aforementioned design, additional mock-ups were created in order to describe the way that each resource contained in the knowledge consumers' site will be presented. Figure 5:40 presents the resource details interface.

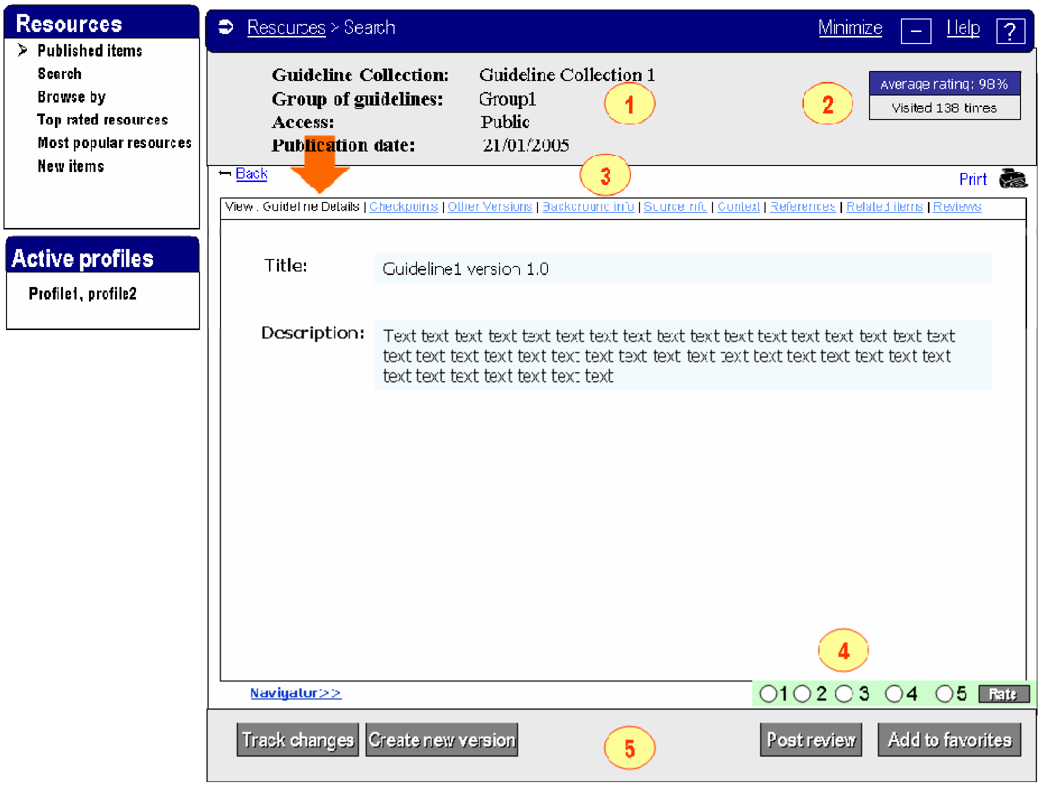


Figure 5:40: The resource details interface

The main areas of this page are:

1. **Resource details:** Contains general information about the resource.
2. **Resource rates – visits:** Displays the average user rating of the resource and the number of times that this resource is visited.
3. **Resource content:** A tab based representation of resource contents.
4. **Rating:** Functionality for collecting user ratings.
5. **Resource functions:** Contains the functions that can be performed on a resource.

On the other hand, the comments made regarding the knowledge developers' site were:

- The initial interface of a project must display the stages and tasks needed to complete the preparation of a report according to the CDGS process.

- For each stage and task, information about its status must appear.

Based on the aforementioned comments, Figure 5:41 present the second iteration of design regarding the knowledge developers' site.

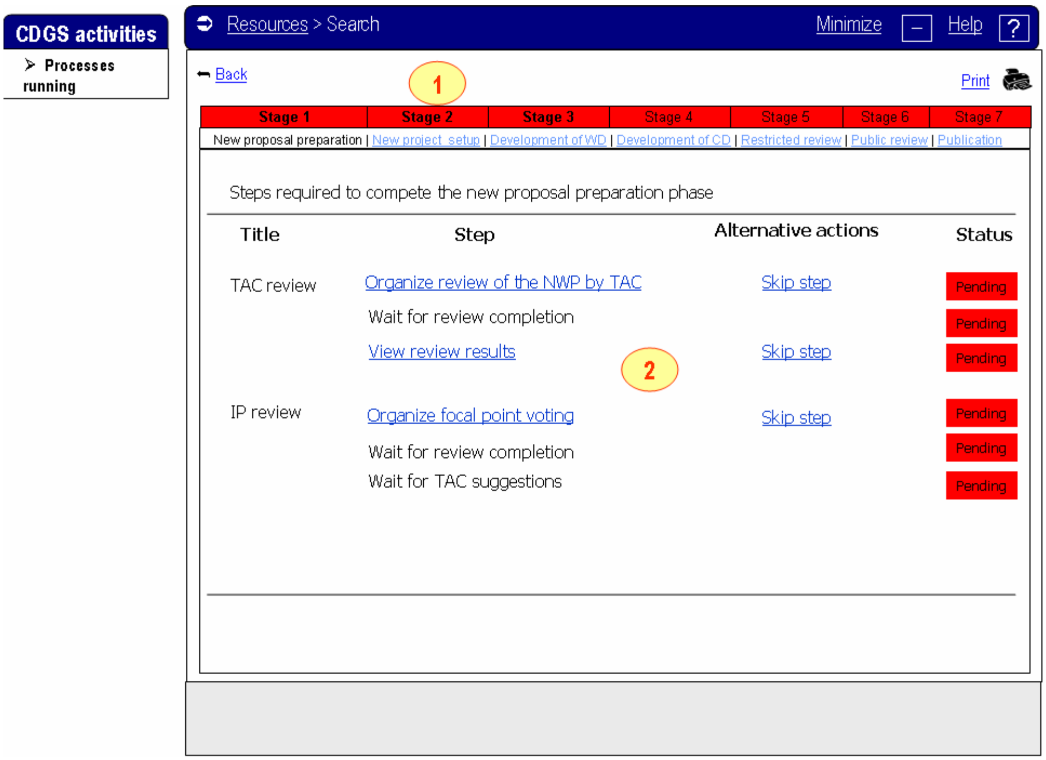


Figure 5:41: The second prototype of the knowledge developers' site

The areas of this page are:

1. **Project stages:** Contain in tabs format the stages that must be completed accompanied with visual clues for the presentation of their completion status.
2. **Stage tasks:** Contains the tasks that must be carried out to complete each stage.

Additionally, during the second design iteration, an attempt aiming at unifying the additional components to be provided to knowledge developers was conducted as shown in Figure 5:42. Components such as news – statistics and notifications are incorporated. Additionally, this design includes a first attempt to generate a user role that can access both knowledge development activities and facilities regarding the retrieval of knowledge through the incorporation of the knowledge consumer's functionality.

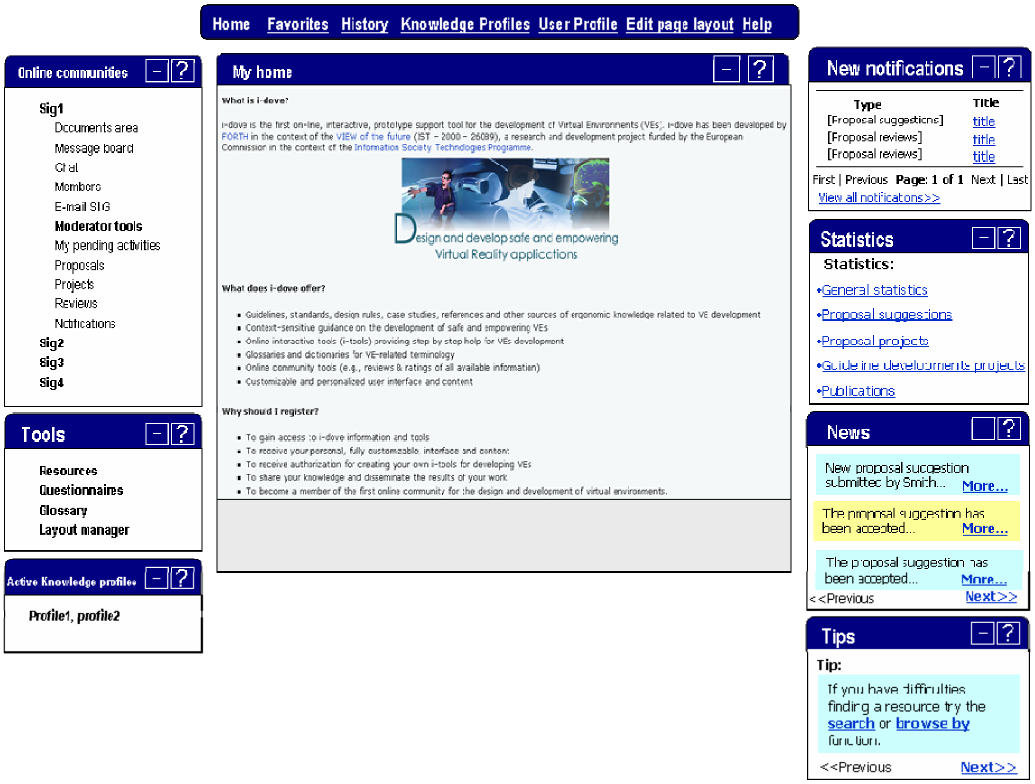


Figure 5:42: Prototype from the second design iteration phase

5.5.3 Final iteration of the user interface design

The feedback received during the evaluation of various mock-ups presented in previous sections produced enough feedback to proceed with the final design of the system. In this stage, a more detailed design approach in terms of user interface presentation and user roles coverage was followed. Designs were elaborated for all the different user roles identified during the user requirements analysis phase. Figure 5:43 displays the final design of the Portal home page.

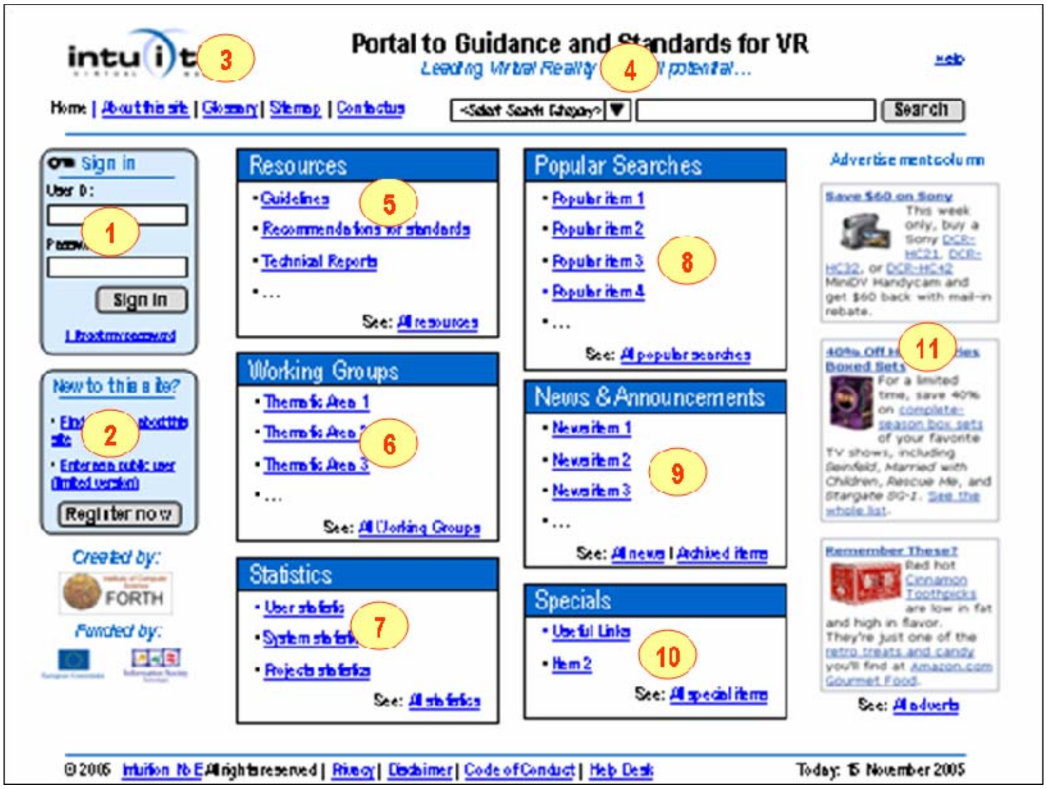


Figure 5:43: The final prototype of the home page

In this figure the main sections and the information or functionality by each of them are identified:

1. **Subscribed users' entrance:** Used by subscribed user to enter their personal area.
2. **Visitor entrance & Public registration:** Provides the ability to enter as a visitor or to register.
3. **Additional information & public tools:** Information about the portal and tools available to Web-surfers.
4. **Search facility:** Keyword based search on site contents.
5. **Latest resources:** Metadata about the latest resources added to the Digital Library.
6. **Working Groups details:** Information about the Working Groups where the standardisation activities are held.
7. **Statistics:** Statistics and figures regarding standardisation activities carried out through the portal.

8. **Popular resources:** Metadata about resources with the highest rating from the digital library.
9. **News & Announcements:** News & Announcements regarding VR Guidance and Standardisation in Europe.
10. **Useful links**: Links to policy makers, standardisation bodies, VR stakeholders, etc.
11. **Advertisements:** Advertisements promoting events, products, services etc.

Figure 5:44 displays the final prototype of the interface provided to visitors of the portal.

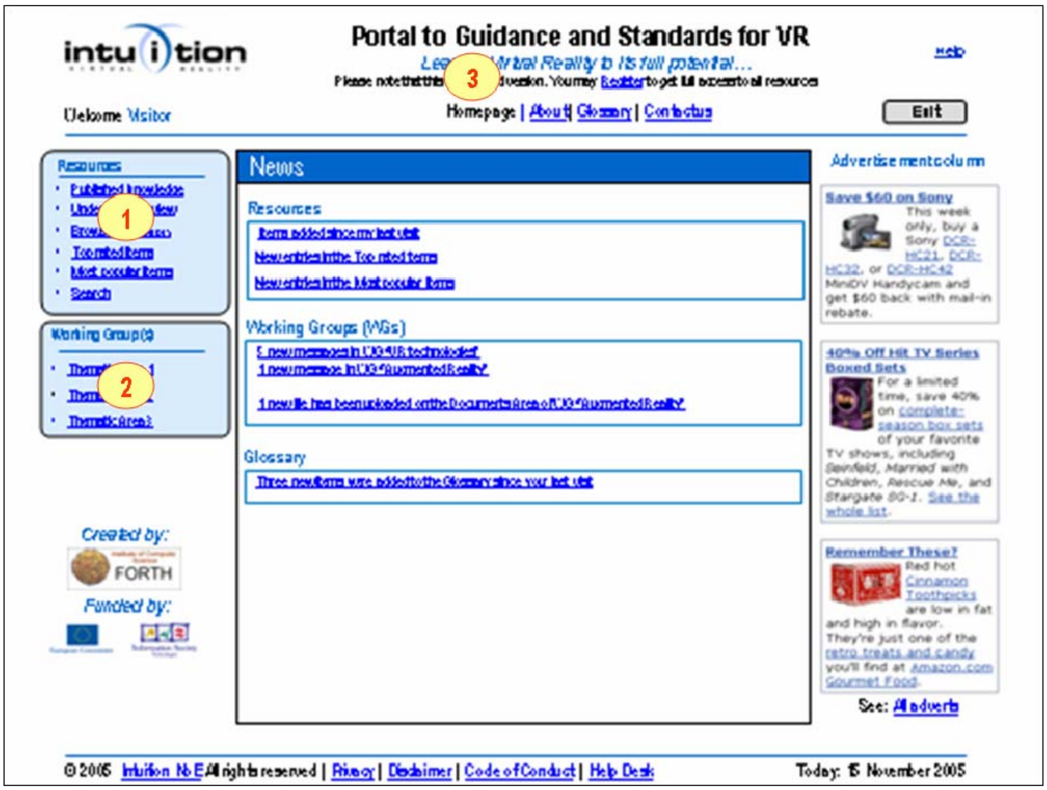


Figure 5:44: The final prototype of the visitor's layout

The basic areas of interest in this page are:

1. **Resources:** Different navigation options for accessing publicly available resources
2. **Working Groups:** A visitor's view of the facilities provided by Working groups
3. **Additional information and public tools:** Information about the portal and tools publicly available for visitors

Figure 5:45 displays the final prototype of the interface provided to knowledge consumers.

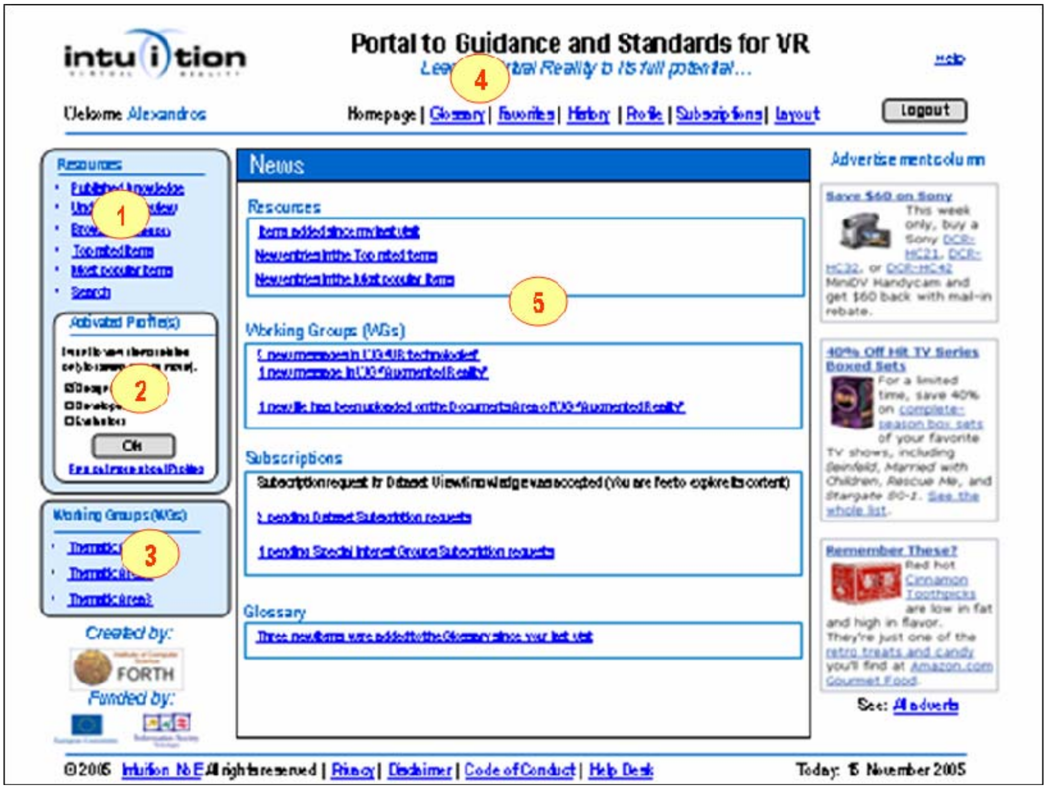


Figure 5:45: The final prototype of the knowledge consumer's layout

The basic areas of interest in this page are:

1. **Resources:** Different navigation options for accessing available resources
2. **Knowledge profiles:** User profiles for filtering results
3. **Working Groups:** The knowledge consumer view of Working Groups
4. **Additional functionality:**
    a. Favourites
    b. History
    c. Glossary
    d. Subscriptions
5. **News & Notifications:** News and personal notifications

Figure 5:46: displays the final prototype of the interface provided to knowledge developers assigned with the roles of WGL WG Member and FP.

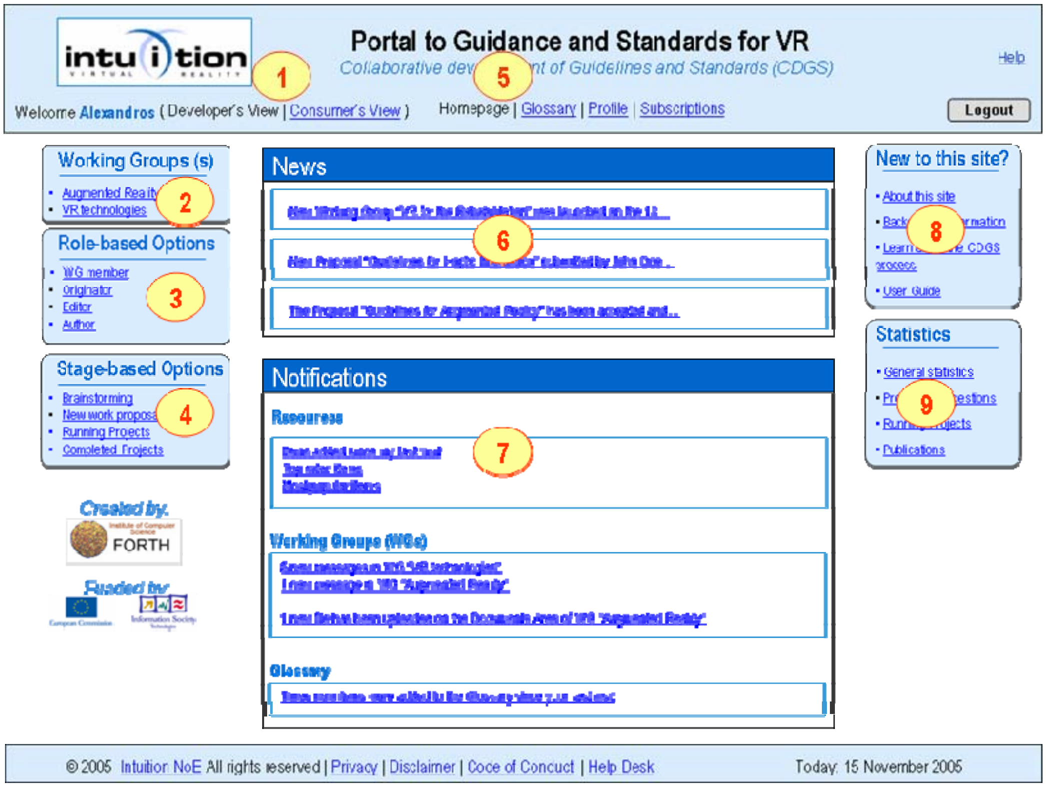


Figure 5:46: The final prototype of the knowledge developer layout (WGL, WGM, and FP)

The basic areas of interest in this page are:

1. **Role-layout switching bar:** Switching between the consumer and developer layout.
2. **Working Groups:** Access to the Working Groups where the standardisation activities are conducted.
3. **Role based options:** Functionality provided according to users role.
4. **Stage based options:** Functionality provided according to the knowledge development phases.
5. **Additional functionality:**
    a. Glossary
    b. Profiles
    c. Subscriptions
6. **News**: News regarding guidance and standardization.
7. **Personal notifications:** A user based repository of personal messages.
8. **Additional information**: Information regarding the portal and the CDGS process.

9. **Statistics:** Statistics and figures regarding the progress of standardisation activities.

On the other hand, users assigned with the roles of ExE, GSE and IP have access to the interface layout presented in Figure 5:47:.

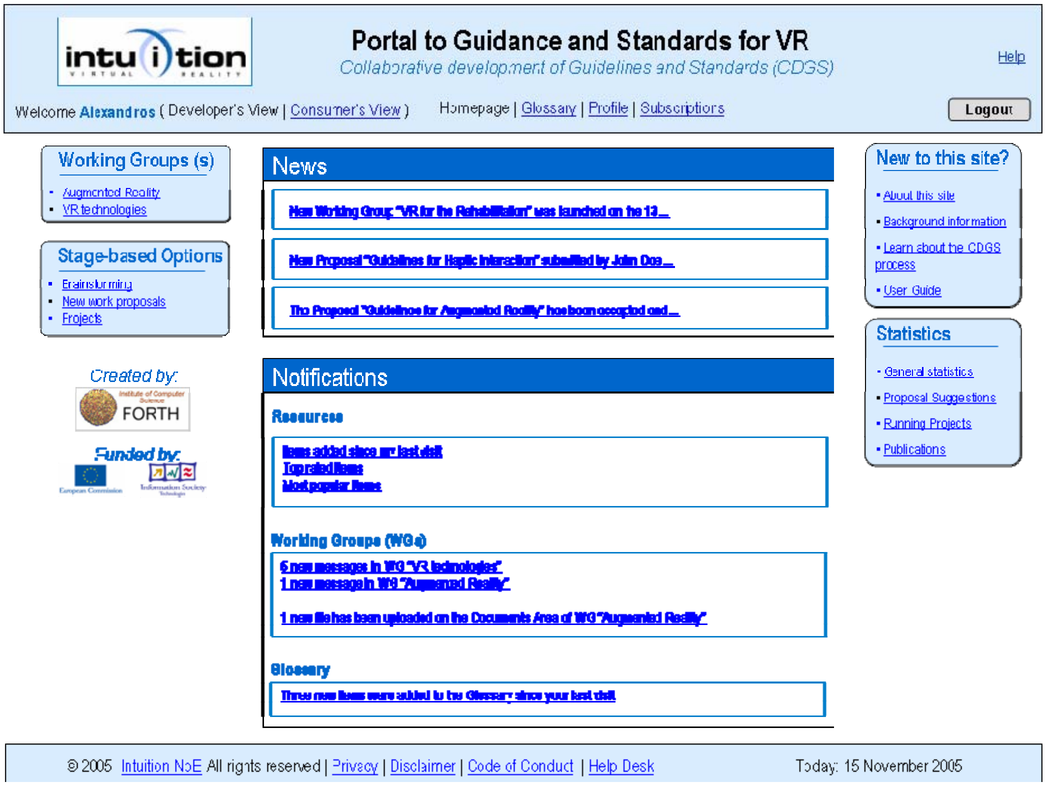


Figure 5:47: The final prototype of the knowledge developer layout (ExE, GsE, and IP)

Complementary to the aforementioned designs, during this phase the basic features to be offered by the modules facilitating the various stages of a CDGS project was identified. More specifically, designs were made to describe the functionality offered by three different modules that represent the three basic steps needed to complete a CDGS project, and namely:

- Brainstorming session
- Proposals
- Projects

Figure 5:48 displays the final prototype of a brainstorming session.

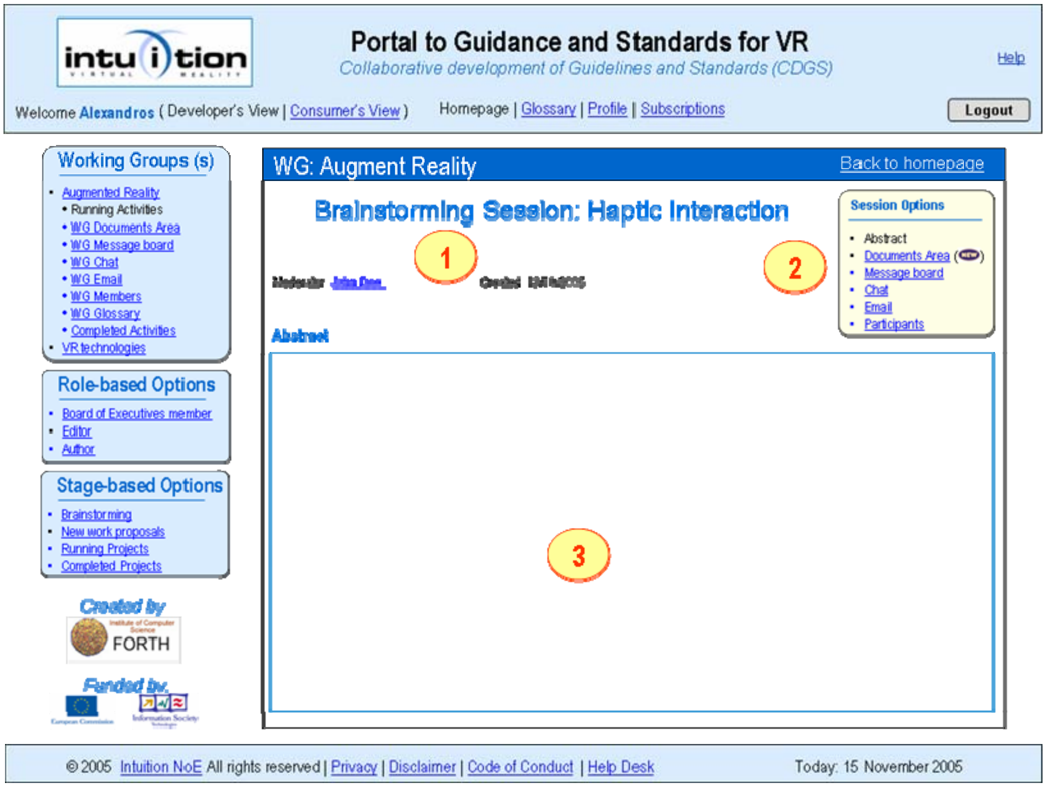


Figure 5:48: The final prototype of the brainstorming sessions module

The basic areas of interest in this page are:

1. Brainstorming details
2. Brainstorming options
3. Functionality according to the selected option

Figure 5:49 displays the final prototype of the proposals module.

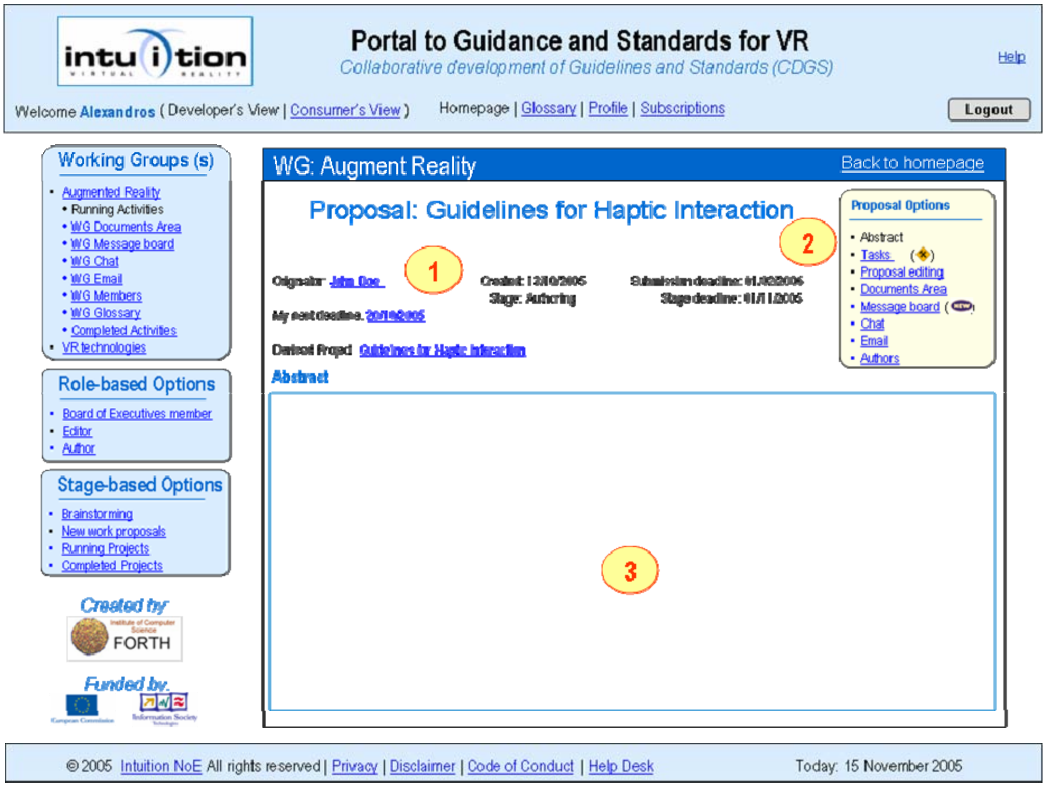


Figure 5:49: The final prototype of the proposals module

The basic areas of interest in this page are:

1. Proposal details
2. Proposal options
3. Functionality according to the selected option

Additionally, Figure 5:50 provides an overview of the final prototype created to describe the stages – tasks module of the proposal. The stages needed to carry out a proposal are identified, accompanied with a representation of the way that each stage will be presented according to their status.

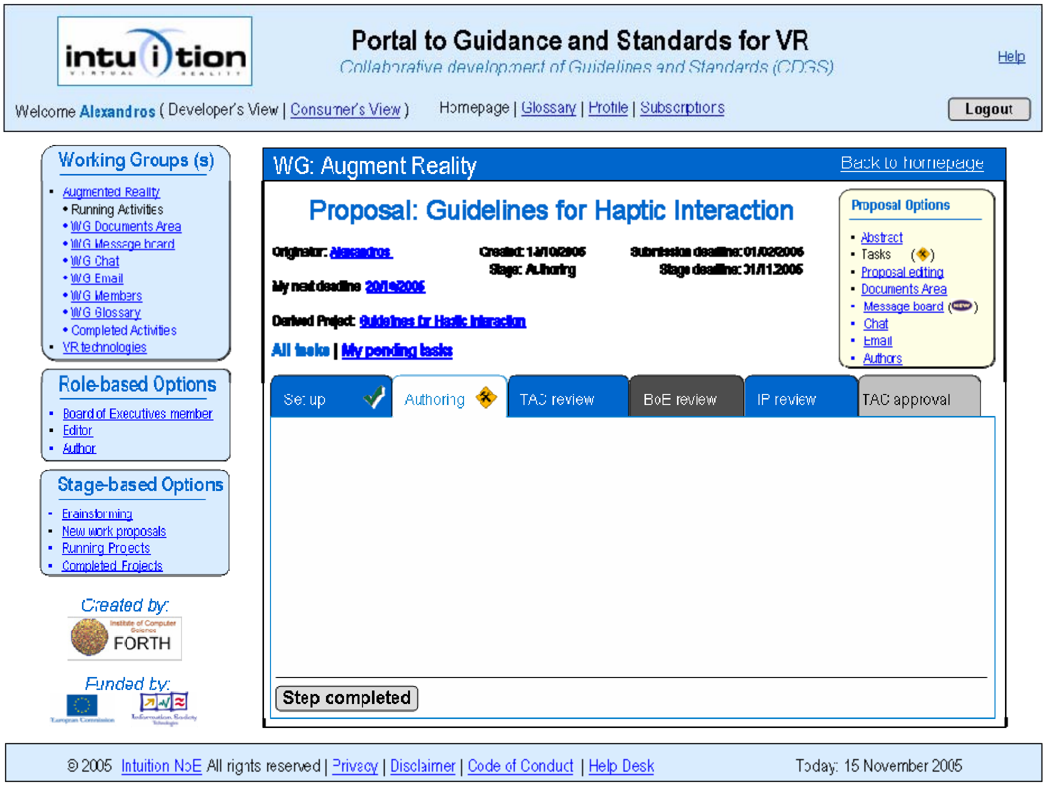


Figure 5:50: The final prototype of the proposal Stages-Tasks interface

Figure 5:51 displays the final prototype of the projects module.

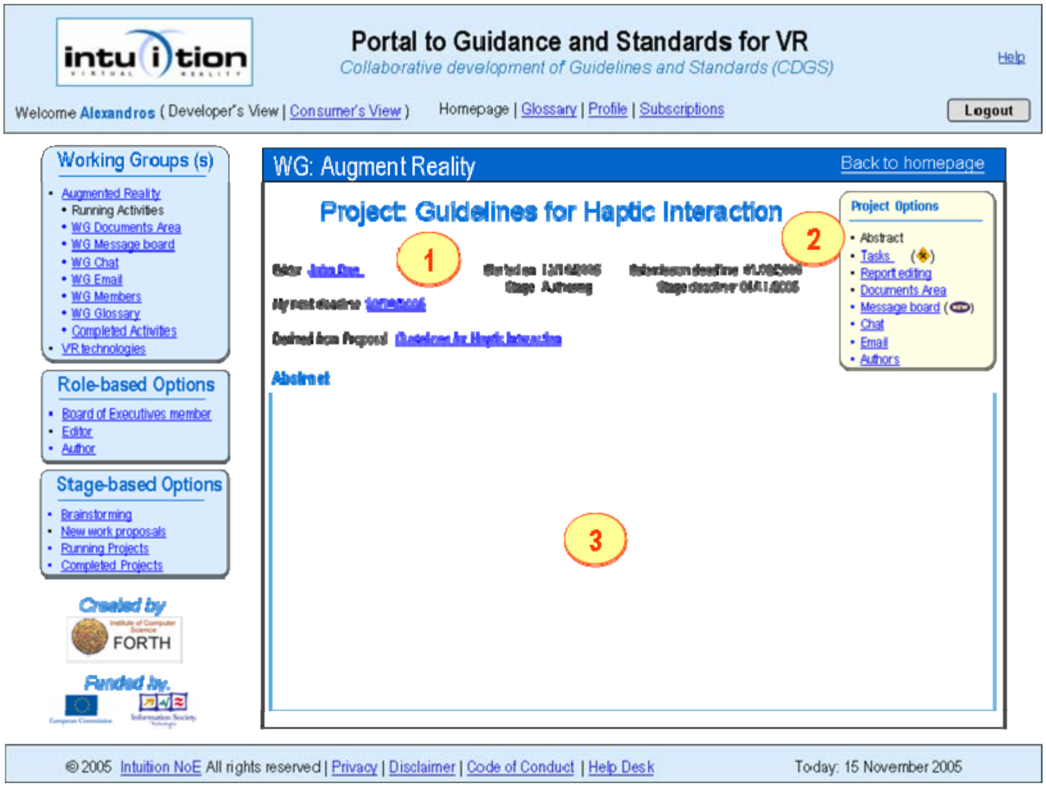


Figure 5:51: The final prototype of the projects module

The basic areas of interest in this page are:

- Project details
- Project options
- Functionality according to the selected option

Figure 5:52 provides an overview of the final prototype created to represent the stages – tasks of a project. In this interface, the stages are presented as tab pages and each of them is displayed using different colour according to the completion status.

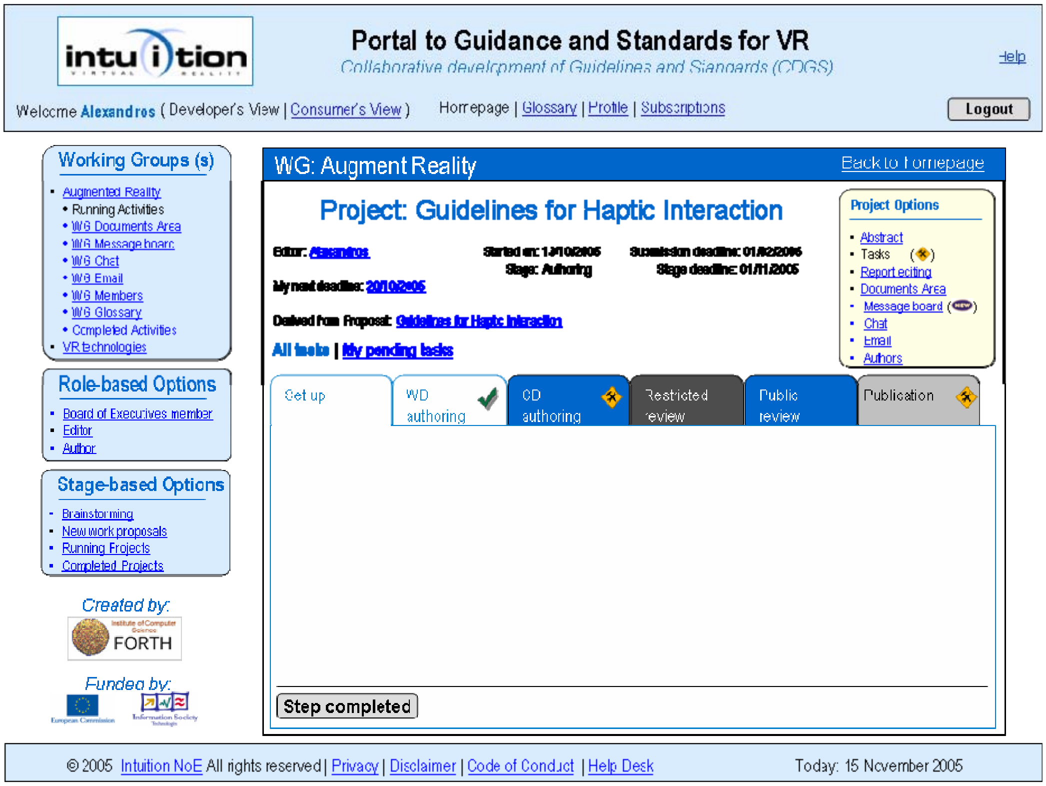


Figure 5:52: The final prototype of the project's Stages-Tasks interface

6. System description

6.1 The Pages for VR knowledge base

6.1.1 Resource classification and organisation

There are two main types of documents / resources that can be developed throughout the process:

- **Single Elements.** These constitute resources that in some way can been perceived as stand alone sources of knowledge and include:
    A. Single Guideline or Rule
    B. Code Template
    C. Design Pattern
    D. Experiment (objectives, set-up, resources and results)
    E. Best Practice Example
    F. Hardware resource (description of a hardware device, peripheral, etc. and any interoperability issues, drivers, etc.)
    G. Software resource (description, source code, etc. of an application)
    H. Reference material
- **Compilations.** These are in the form of the following digital documents that can be produced throughout the process:
    I. Proposal for a new "project"
    J. Publicly Available Specification
    K. Technical Report
    L. Technical Specification
    M. Internal Workshop Agreement
    N. Collection of Guidelines
    O. Recommendations for new or revised standard
    P. Draft Standard

Q. Internal Standard

- **Datasets.** Groups of Compilations and / or Single elements.

The Pages for VR 'knowledge base' is organised as follows:

- At a first level, the 'knowledge base', consists of Datasets; each Dataset has an administration team, user group and may contain one or more Compilations and/or Single Elements;
- Compilations can contain one or more Single Elements of one of the following types: Guideline or Rule, Code Template, Design Pattern, Experiment, Best Practice Example, Hardware resource, Software resource;
- Furthermore, any resource (Single element or Compilation) can be linked to a number of other resources through:
    - direct connections, which are used as a means for linking directly related items (e.g., a number of Guidelines may have direct connections to a specific Experiment);
    - indirect connections, which are used for cross-referencing items that belong to different Compilations or/and Datasets classifications but have something in common (e.g., common themes);

In Figure 6:1 some example links are depicted as dotted lines

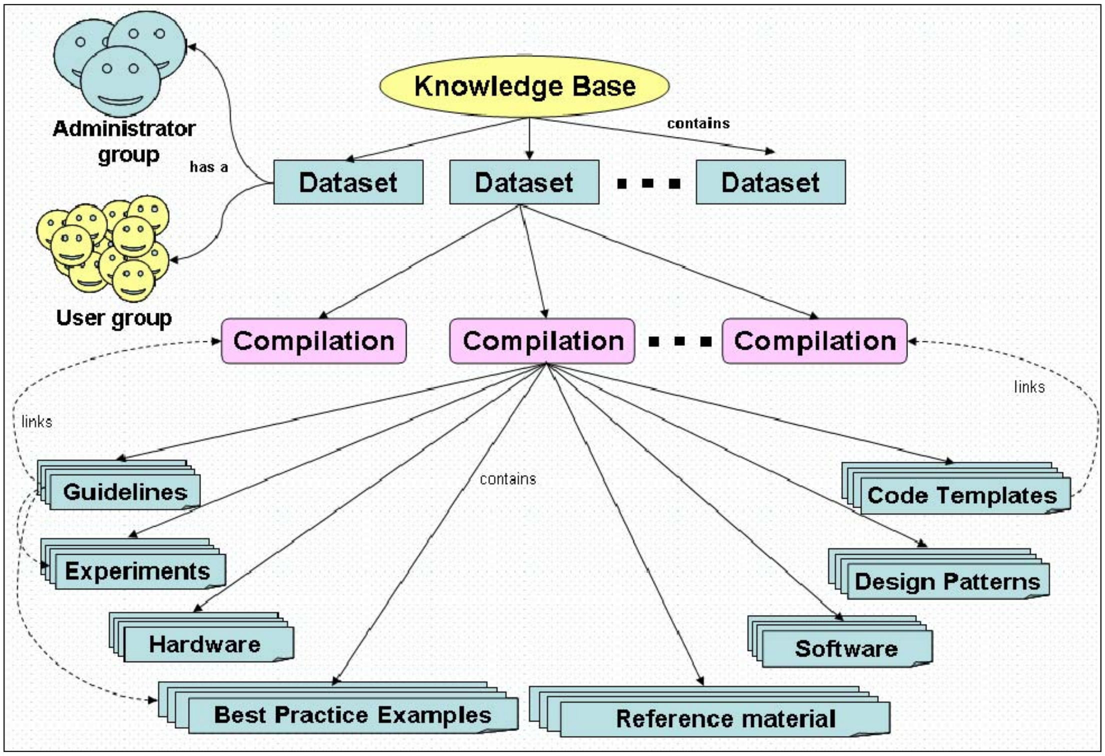


Figure 6:1: Classification of Pages for VR resources

6.1.2 Resource attributes

6.1.2.1 Single Elements

6.1.2.1.1 Guidelines

In order to describe Pages for VR Guideline or Rule the following (meta-) data are used (Table 6:1):

Guideline	
Attributes	**Description**
General info	
Title	Guideline title.
Author(s) / producing organisation	The authors of the resource's content (can be physical persons or organisations).
Source	A reference (bibliographic, URL, etc.) to the original document / context in which the content of the resource can be found.
Year	The year that the content of the resource was originally published.
Guideline details	
Guideline number	The number of this guideline in the context of a collection of guidelines.
Keywords	A list of representative keywords edited by the resource's Editors, which

Guideline	
Attributes	**Description**
	represents the content.
Checkpoints	
Title	A descriptive, and preferably distinctive, title for the checkpoint.
Comments	Comments from the editor of the guideline.
Importance	The importance of the specific checkpoint.
Checkpoint Examples	
Example(s) Title	A descriptive, and preferably distinctive, title about conforming to the checkpoint.
Example Description	A short description of the example.
Example Attachment	An attachment containing the example in electronic form.
Other versions	
List of other versions	A list of other versions of the specific guideline.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.
Related items	
List of related items	Items that are in some way related with the specific Guideline.
Implementation examples	
Title	A short descriptive title for the example
Description	A short text outlining the contents of the example.
Attachment	An attachment related with the example or the example itself
Reviews	
Reviewer(s)	The person(s) making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:1: Metadata used to describe guidelines

6.1.2.1.2 Experiments

In order to describe Pages for VR Experiments, the following (meta-) data are used (Table 6:2):

Experiment	
Attributes	**Description**
General info	
Title	A descriptive, and preferably distinctive, title.
Source	The source of the experiment.

Experiment	
Attributes	**Description**
Authors / producing organisation	The authors of the resource's content (can be physical persons or organisations).
Year	The year that the content of the resource was originally published.
Experiment Details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Start date	The experiment's start date
End date	The experiment's end date
Annual cost	The experiment's annual cost
Project name	The project under witch the experiment was held
Background info	
Objectives	What the resource aims to help achieving (e.g., improve usability, decrease errors, provide a reusable 3D menu).
Motivation / Rationale	A justification of the resource's content (validity, underlying principles, background, etc.)
Settings	Information about the experiment settings.
Method	The method used to conduct the experiment.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.
Related items	
List of related items	Items that are in some way related with the resource.
Contacts	
Organisation name	The contact's organisation
Organisation acronym	The acronym of the organisation
Department name	The Department within the institute.
Country	The county were the contact is located
State of providence	
Street	Contact street
City	Contact city
Postal_code	Contact postal code
Organisation's url	Contact url
Contact person	The contact name

Experiment	
Attributes	**Description**
name	
Contact person surname	The contact surname
Person title	The contact title
Person telephone	The contact telephone
Person Fax	The contact fax
Person URL	The contact url
Person email	The contact email

Table 6:2: Metadata used to describe experiments

6.1.2.1.3 Design patterns

In order to describe Pages for VR Design patterns, the following (meta-) data are used (Table 6:3):

Design pattern	
Attributes	**Description**
General info	
Title	A descriptive, and preferably distinctive, title.
Authors / producing organisation	The authors of the resource's content (can be physical persons or organisations).
Source	A reference (bibliographic, URL, etc.) to the original document / context in which the content of the resource can be found.
Year	The year that the content of the resource was originally published.
Design pattern details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Background info	
Applicability	The conditions / circumstances (when and where) under which the resource can (or cannot) be employed (e.g., large virtual worlds, HMD-based systems, multi-user environments)
Guidance	Advice on how the resource can and should be used.
Prerequisites	Description of the prerequisites needed.
Benefits	Description of the benefits gained by its use.
Drawbacks	The limitations of the specific solution.
Motivation/problem	The motivation for the solution or the problem solved by this resource
Other issues	Other issues related with the resource
Downloads	
Diagrams	A list of diagrams that are representing or are related with the resource.
Code examples	Implementation examples in the form of source code.
List of images	A list of images related to the resource.

Design pattern	
Attributes	**Description**
List of demos	A list of demos related to the resource in various formats.
Related items	
List of related items	Items that are in some way related with the resource.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.

Table 6:3: Metadata used to describe design patterns

6.1.2.1.4 Code templates

In order to describe Pages for VR Code templates, the following (meta-) data are used (Table 6:4):

Code template	
Attributes	**Description**
General info	
Title	A descriptive, and preferably unique, name.
Authors / Producing organization	The authors of the resource's content (can be physical persons or organisations).
Year	The year that the content of the resource was originally published.
Source	A reference (bibliographic, URL, etc.) to the original document / context in which the content of the resource can be found.
Design pattern details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Background info	
Applicability	The conditions / circumstances (when and where) under which the resource can (or cannot) be employed (e.g., large virtual worlds, HMD-based systems, multi-user environments)
Guidance	Advice on how the resource can and should be used.
Prerequisites	Description of the prerequisites needed.
Benefits	Description of the benefits gained by its use.
Drawbacks	The limitations of the specific solution.
Motivation/problem	The motivation for the solution or the problem solved by this resource
Other issues	Other issues related with the resource
Downloads	

Code template	
Attributes	**Description**
Diagrams	A list of diagrams that are representing or are related to the resource.
Code examples	Implementation examples in the form of source code.
List of images	A list of images related with the resource.
List of demos	A list of demos related to the resource in various formats.
Related items	
List of related items	Items that are in some way related to the resource.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.

Table 6:4: Metadata used to describe code templates

6.1.2.1.5 Hardware products

In order to describe Pages for VR Hardware products, the following (meta-) data are used (Table 6:5):

Hardware product	
Attributes	**Description**
General info	
Title	A descriptive, and preferably unique, title.
Hardware product details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Price	The price of the software product.
Company info	
Company name	The name of the company producing the product.
Street	The street of the company's office.
City	The city where the company resides.
Country	The country where the company resides.
Faxes	A number of fax numbers to contact the company.
E-mails	A number of email addresses to contact the company.
Urls	The address where the company's web-site resides.
Phones	A number of phone numbers to contact the company.
Technical specification	
Version / Year	The product version.

Hardware product	
Attributes	**Description**
Code	The code representing the specific product.
Model	The model or the product.
Downloads	
Drivers	The drivers of the hardware product.
List of images	A list of images related to the resource.
List of demos	A list of demos related to the resource in various formats.
Related links	
List of related links	A number of links related to the specific hardware product.
Related items	
List of related items	Items that are in some way related to the resource.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:5: Metadata used to describe hardware products

6.1.2.1.6 Software products

In order to describe Pages for VR Software products, the following (meta-) data are used (Table 6:6):

Software product	
Attributes	**Description**
General info	
Title	A descriptive, and preferably unique, title.
Software product details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Price	The price of the software product.
Company info	
Company name	The name of the company producing the product.
Street	The street where the company resides.
City	The city where the company resides.
Country	The country where the company resides.
Faxes	A number of fax numbers to contact the company.
E-mails	A number of email addresses to contact the company.
Urls	The address where the company's web-site resides.
Phones	A number of phone numbers to contact the company.
Technical specification	
Version / Year	The product version – year.
Operating system(s)	The operating system(s) that the specific program is compatible with

Software product	
Attributes	**Description**
Downloads	
Files	A list of files related to the resource in various formats.
Related links	
List of related links	A number of links related to the specific product.
Related items	
List of related items	Items that are in some way related to the resource.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:6: Metadata used to describe software products

6.1.2.1.7 Best practice examples

In order to describe Pages for VR Best practice examples, the following (meta-) data are used (Table 6:7):

Best practice example	
Attributes	**Description**
General info	
Title	A descriptive, and preferably unique, title.
Year	The year that the content of the resource was originally published.
Best practice details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Background info	
Aim	A short text outlining the aim of the resource.
Stakeholders	A short text outlining the stakeholders involved.
Place	
Results	A short text outlining the results of the best practice example.
Approach	A short text outlining the approach followed by the best practice example.
Strengths / Weaknesses	A short text outlining the strengths and weaknesses identified for the best practice example.
Organization details	
Organization name	The name of the organization responsible for producing the best practice example.
Street	The street where the organization resides.
City	The city where the organization resides.
Country	The country where the organization resides.
Fax	A number of fax numbers to contact the organization.
E-mail	A number of email addresses to contact the organization.

Best practice example	
Attributes	**Description**
Url	The address where the organization's web-site resides.
Phone	A number of phone numbers to contact the organization.
Contacts	
Type	Type of contact
Institute name	The contact's institute
Institute acronym	The acronym of the Institute
Department name	The Department within the institute.
Department acronym	The acronym of the Department
Country	The country where the institute resides.
State of providence	
Place	
Street	The street where the institute resides.
City	The city where the institute resides.
Postal_code	The postal code of the institute
url	The address where the institute web-site resides.
Person name	The name of a person within the institute acting as contact person.
Person surname	The surname of a person within the institute acting as contact person.
Title	The title of the person acting as contact person.
Telephone	A number of phone numbers to contact the specific person.
Person Fax	A number of fax numbers to contact the specific person.
Person URL	The address where the person's web-site resides.
Person email	A number of email addresses to contact the specific person.
Downloads	
Diagrams	A list of diagrams that are representing or are related with the resource.
Code examples	Implementation examples in the form of source code.
List of images	A list of images related with the resource.
List of demos	A list of demos related to the resource in various formats.
Related items	
List of related items	Items that are in some way related to the resource.
Examples	
Title	A descriptive, and preferably distinctive, title for the example.
Description	A short text outlining the contents of the example.
Attachment	An attachment containing the example in electronic form.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:7: Metadata used to describe best practice examples

6.1.2.1.8 Reference material

In order to describe Pages for VR Reference material, the following (meta-) data are used (Table 6:8):

Reference material	
Attributes	**Description**
General info	
Title	A descriptive, and preferably distinctive, title.
Authors / Producing organization	The authors of the resource's content (can be physical persons or organisations).
Source	A reference (bibliographic, URL, etc.) to the original document / context in which the content of the resource can be found.
Year	The year that the content of the resource was originally published.
Reference material details	
Abstract	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Content	
File	A file representing the content of the reference material
Resources	A number of resources representing the content of the reference material
Text	Formatted or unformatted text acting as content of the reference material
Background	
Objectives	What the resource aims to help achieving (e.g., improve usability, decrease errors, provide a reusable 3D menu).
Rationale	A justification of the resource's content (validity, underlying principles, background, etc.)
Applicability	The conditions / circumstances (when and where) under which the resource can (or cannot) be employed (e.g., large virtual worlds, HMD-based systems, multi-user environments)
Guidance	Advice on how the resource can and should be used.
Context	
User roles	One or more user roles (i.e., profiles) the resource is intended or interesting for, e.g., Decision Maker, Designer, Developer/Engineer, Test/Evaluation Expert, End-user, and Academic.
Development phases	The development phase during which this resource can be useful, e.g., Planning and requirements, Design, Evaluation and testing, Implementation, Deployment, Maintenance, or Use.
User tasks	The user tasks identified for each user role.
Application domains	The application domain(s) the resource is related to, e.g., Medical Training & Simulation, Scientific Visualisation, Engineering Design, Architectural Design, or Entertainment.
VE representation & interaction	Modelling & Representation (e.g., Visual, Aural, or Haptic) and Interaction (Navigation, Selection, Manipulation, etc.) issues the resource is related to.

Reference material	
Attributes	**Description**
Hardware	The computer components (CPU, graphics card, memory), input and output devices, that the resource uses or is indented for.
Software	Characteristics of the software (run-time, modelling, operating system, programming language), the resource uses or is indented for.
General issues	Some general VE issues the resource is related to, such as Immersion, Presence, Performance, Portability, User mobility, Cost, Health & safety.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:8: Metadata used to describe reference material

6.1.2.2 Compilations

6.1.2.2.1 Proposal outcomes

In order to describe Pages for VR Proposal outcomes, i.e.:

- Proposals for new Project (PrPs)
- Publicly available specifications (PaS)
- Technical Reports (TR)

the following (meta-) data are used (Table 6:9):

Proposal outcomes	
Attributes	**Description**
General info	
Title	A descriptive, and preferably distinctive, title (The title of the proposal).
Authors / Producing organization	The authors of the resource's content (can be physical persons or organisations). More specifically the persons participating in the proposal preparation.
Source	A reference (bibliographic, URL, etc.) to the original document / context in which the content of the resource can be found.
Year	The year that the content of the resource was originally published.
Collection details	
Abstract	A short text outlining the contents of the resource (the proposal's abstract).
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.

Proposal outcomes	
Attributes	**Description**
Content	
Text	Formatted or unformatted text acting as content of the proposal (the union of the content created by proposal editors during the proposal development phases).
Background	
Objectives	What the resource aims to help achieving (e.g., improve usability, decrease errors, provide a reusable 3D menu).
Rationale	A justification of the resource's content (validity, underlying principles, background, etc.)
Applicability	The conditions / circumstances (when and where) under which the resource can (or cannot) be employed (e.g., large virtual worlds, HMD-based systems, multi-user environments)
Guidance	Advice on how the resource can and should be used.
Context	
User roles	One or more user roles (i.e., profiles) the resource is intended or interesting for, e.g., Decision Maker, Designer, Developer/Engineer, Test/Evaluation Expert, End-user, and Academic.
Development phases	The development phase during which this resource can be useful, e.g., Planning and requirements, Design, Evaluation and testing, Implementation, Deployment, Maintenance, or Use.
User tasks	The user tasks identified for each user role.
Application domains	The application domain(s) the resource is related to, e.g., Medical Training & Simulation, Scientific Visualisation, Engineering Design, Architectural Design, or Entertainment.
VE representation & interaction	Modelling & Representation (e.g., Visual, Aural, or Haptic) and Interaction (Navigation, Selection, Manipulation, etc.) issues the resource is related to.
Hardware	The computer components (CPU, graphics card, memory), input and output devices, that the resource uses or is indented for.
Software	Characteristics of the software (run-time, modelling, operating system, programming language), the resource uses or is indented for.
General issues	Some general VE issues the resource is related to, such as Immersion, Presence, Performance, Portability, User mobility, Cost, Health & safety.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:9: Metadata used to describe proposal outcomes

6.1.2.2.2 Project outcomes

In order to describe Pages for VR project outcomes, i.e.,:

- Technical Specifications
- Internal Workshop Agreement
- Collection of Guidelines
- Recommendations for new or revised standard
- Draft Standard
- Internal Standard
- Technical Reports (TRs)

the following (meta-) data are used (Table 6:10):

Project outcomes	
Attributes	**Description**
General info	
Title	A descriptive, and preferably distinctive, title.
Authors / Producing organization	The authors of the resource's content (can be physical persons or organisations). More specifically the persons that participated in the proposal preparation and to the project report drafting.
Source	A reference (bibliographic, URL, etc.) to the original document / context in which the content of the resource can be found.
Year	The year that the content of the resource was originally published.
Collection details	
Description	A short text outlining the contents of the resource.
Keywords	A list of representative keywords edited by the resource's Editors, which represents the content.
Childs	
List of resources or files	A number of resources or files acting as the content of the specific resource.
Background	
Objectives	What the resource aims to help achieving (e.g., improve usability, decrease errors, provide a reusable 3D menu).
Rationale	A justification of the resource's content (validity, underlying principles, background, etc.)
Applicability	The conditions / circumstances (when and where) under which the resource can (or cannot) be employed (e.g., large virtual worlds, HMD-based systems, multi-user environments)
Guidance	Advice on how the resource can and should be used.
Context	
User roles	One or more user roles (i.e., profiles) the resource is intended or interesting for,

Project outcomes	
Attributes	**Description**
	e.g., Decision Maker, Designer, Developer/Engineer, Test/Evaluation Expert, End-user, and Academic.
Development phases	The development phase during which this resource can be useful, e.g., Planning and requirements, Design, Evaluation and testing, Implementation, Deployment, Maintenance, or Use.
User tasks	The user tasks identified for each user role.
Application domains	The application domain(s) the resource is related to, e.g., Medical Training & Simulation, Scientific Visualisation, Engineering Design, Architectural Design, or Entertainment.
VE representation & interaction	Modelling & Representation (e.g., Visual, Aural, or Haptic) and Interaction (Navigation, Selection, Manipulation, etc.) issues the resource is related to.
Hardware	The computer components (CPU, graphics card, memory), input and output devices, that the resource uses or is indented for.
Software	Characteristics of the software (run-time, modelling, operating system, programming language), the resource uses or is indented for.
General issues	Some general VE issues the resource is related to, such as Immersion, Presence, Performance, Portability, User mobility, Cost, Health & safety.
References	
Authors	The authors of the specific reference.
Title	The title of the referenced document.
Year	The year that the referenced document was published.
Publication info	Information regarding the publication details or the referenced document.
Reviews	
Reviewer(s)	The person making the review.
Comments / Suggestions	The reviewer comments / suggestion made by the reviewer for improving the specific resource.

Table 6:10: Metadata used to describe project outcomes

6.1.2.2.3 Datasets

In order to describe Datasets, the following (meta-) data are used (Table 6:11):

Guideline	
Attributes	**Description**
General info	
Title	A descriptive, and preferably distinctive, title.
Editor(s)	The user(s) who created the Dataset and have the right to edit it.
Note	A note by the Editor(s) of the Dataset. It can be any text and act e.g., as a copyright notice, a disclaimer, or even as an “advertisement”. This text is always visible whenever the Dataset is displayed / presented
References	A list of references that appear / relate to the Dataset.
Description	A short text to introduce the Dataset and outline its contents.

Guideline	
Attributes	**Description**
Guideline number	The number of this guideline in the context of a collection of guidelines.
Content	A list of the Collections and / or Basic Resources that the Dataset contains.

Table 6:11: Metadata used to describe datasets

6.1.3 Content – related Issues

During the design of Pages for VR some important issues were raised regarding the content and its origin:

a) Authorship / copyright / intellectual property

An important issue in an on-line tool that integrates content from various sources is (a) the identification of the author(s) and the origin (i.e., document) of every single item included in, and presented by, the tool, as well as (b) the identification of the editor(s).

➔ To address this issue, each resource is always associated with its author(s) and source, as well as with the person who inserted it into the database (a note created by the person who added it in the tool's database). This information is always visible whenever the contents of the resource are displayed and cannot be hidden / deactivated.

b) Original context

Often, design guidance statements remain valid only within the context in which they were originally generated (for instance input devices for single user VEs may have different requirements than input devices for multi-user VEs). If any of these guidelines are presented without the original context (source), the authors might be held responsible for any induced problems to end-users.

➔ To avoid such problems, each resource has a source, i.e., reference to the original context in which this was / is made available). Furthermore, a set of meta-data is used for describing the objectives, rationale and the applicability of the resource, as well as guidance on its use and the context of application (user roles, tasks, development phase, application domains, hardware, software, etc.) in which it is valid. This is edited by the editor of the resource.

c) Referencing / quotations / plagiarism

Some resources may be based on the work of other parties. Thus, if the original author references are not quoted, then the resource creators could be held liable for plagiarism.

➔ A list of related references can be assigned to each resource. Furthermore, a mechanism is provided for the creators of resources, allowing them to include in the content and meta-data of the resource links to those references.

6.2 The Pages for VR Portal

During the development of the Pages for VR portal, functionality previously developed by the HCI lab of ICS-FORTH to support the needs of special interest groups were used. This functionality includes chat, documents area, message board and glossary. Whenever needed, this functionality was modified or enhanced in order to address new requirements.

6.2.1 User categories and roles

Users participating to activities within the portal or accessing the services provided by the portal with or without registration can be divided into the following categories

Web surfers

- *awareness about the objectives of INTUITION work on guidelines*

Anonymous visitors

- *preliminary experience of the look-and-feel of the portal and of the type of resources available*

Registered users

- **Knowledge consumers**
  - *consulting the guidance-related knowledge published by INTUITION*
- **Knowledge developers / contributors**
  - *primary or secondary role in the development of knowledge*
- **Knowledge administrators**
  - *users who wish to extend or update the knowledge base of the tool*

Some of the aforementioned main categories of users can be further subdivided into more specific hierarchies of roles, such as:

Knowledge Consumers

- **Simple users:** These are users that have subscribed to the portal in order to *consulting the guidance-related knowledge published.*
- **SIG moderators:** These are users moderating a Special Interest Group.

Knowledge Developers

- **WG Members:** These are users who participate to brainstorming sessions.
- **Originator**: This is a users proposing the preparation of a new set of guidelines or standards (i.e., preparing and submitting a Proposal for a new "project").
- **Editor**: This is typically the same person with the Originator and, upon the approval of the proposal, is responsible for drafting the new set of guidelines or a standard. To this end, the editor is also responsible for co-ordinating the work of all involved Authors.
- **Authors**: These are users contributing to the drafting of a proposal or a report as the main outcome of a "project".

Knowledge Contributors

- **External Experts (ExEs):** These are external individuals (i.e., other than corresponding WG members) with technical expertise related to the topic of a Project, and who are willing to review and provide comments on (draft versions of) the corresponding Report / Document.
- **Interested Parties (IPs):** Individuals who represent the target market for the Reports of a particular WG. Interested Parties are offered the right to vote and comment upon Proposals and (draft versions of) new Reports emerging from the corresponding WG.
- **Guidelines & Standardisation Experts (GSEs):** These are INTUITION partners with expertise in procedural and normative matters. They are mainly responsible for the quality of the Report delivered by Editors.

Executive / Administrative roles

- **NMC members (Network Management Committee)**: This is a group of INTUITION partners who are responsible for the operational work issues and general decision making with regards to the entire Process. The responsibilities of the NMC members_include: the overall management of the WGs structure (including the assignment and replacement of WGLs), the establishment and dissolution of WGs, the delineation of WGs' scope, other coordination issues.

- **NMC Leader**: This person is responsible for the co-ordination of the NMC discussions and for making the ultimate decisions when necessary.
- **WG Leader:** This is an individual moderating a WG.
- **Focal Points (FP):** These are INTUITION partners within a WG, nominated by the corresponding WG Leader, to administrate and act as contact persons to the WG's Interest Parties.

Each of the aforementioned user roles has its own functionality and thus interfaces. Additionally, the look and feel of the interface provided varies from one category of users to the other. A schematic representation of the aforementioned roles in relation to the sharing of functionality among these roles is presented in Figure 6:2.

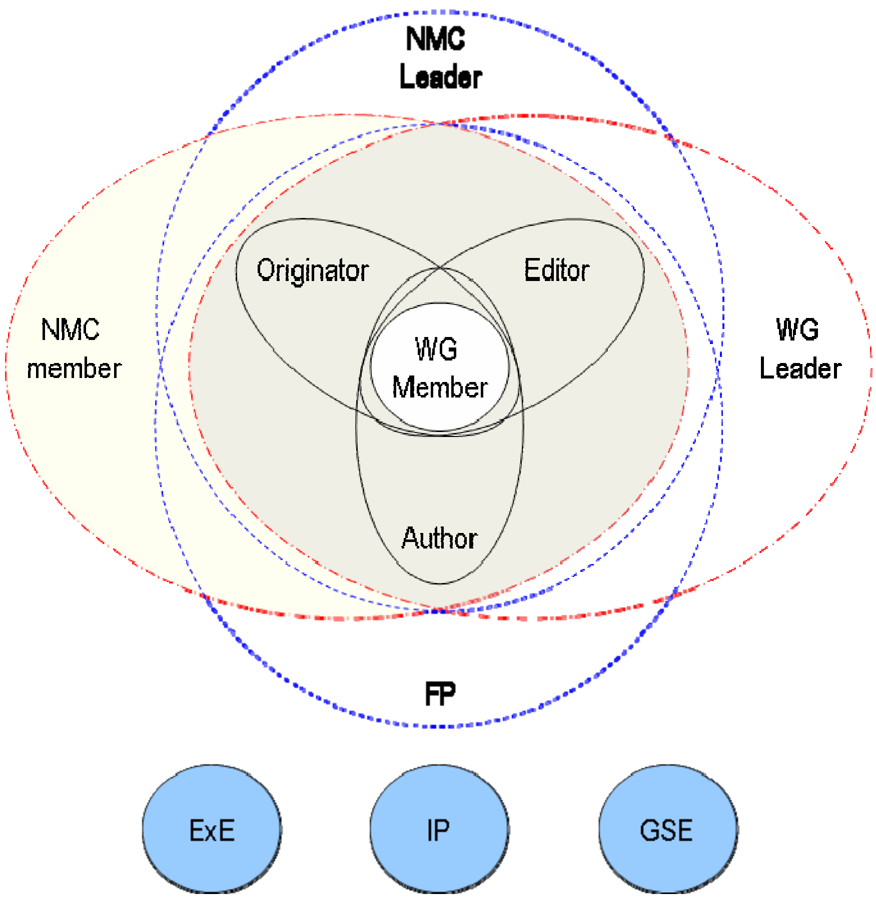


Figure 6:2: Portal roles and sharing of functionality

The core level is that of Developers ,starting with WG Members that can participate to brainstorming sessions and continuing with Originators, Editors and Authors that have some additional tasks (different among them). Executives / Administrative roles share the same functionality with Developers (i.e., potentially they can also be Authors), plus some extra functions. Finally, Contributors (ExEs, IPs, and GSEs) have completely different tasks.

6.2.2 Web surfers

The public area of the portal aims at informing the site's visitors about the scope and objectives of the INTUITION work on guidelines. This can be achieved by accessing the several facilities provided by the public area of the portal presented in Figure 6:3.

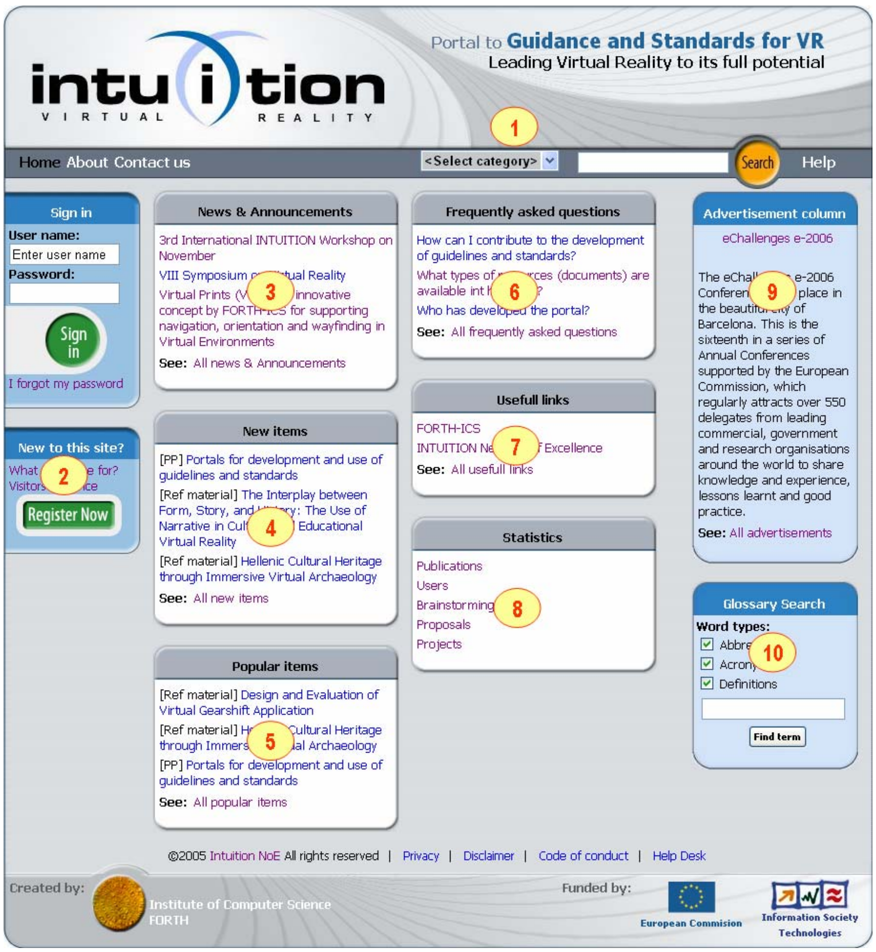


Figure 6:3: The basic areas of interest for Web-surfers

There are nine areas of interest, and namely:

1. **Search area**

2. **Registration**
3. **News & Announcements**
4. **New items**
5. **Popular items**
6. **Frequently asked questions:**
7. **Links**
8. **Statistics**
9. **Advertisements**
10. **Glossary**

Each of these sub-areas and the functionality provided is analysed in depth in the following sections.

6.2.2.1 Search

The search facility allows web surfers to search the portal content based on a number of search categories, such as:

- Advertisements
- News
- Links
- Resources
- Site content

The submission of a query, results to a keyword based search of the public items available for the selected category. The selection of a search result navigates to the interface responsible for displaying its contents according to the result type. The overall process is presented in Figure 6:4

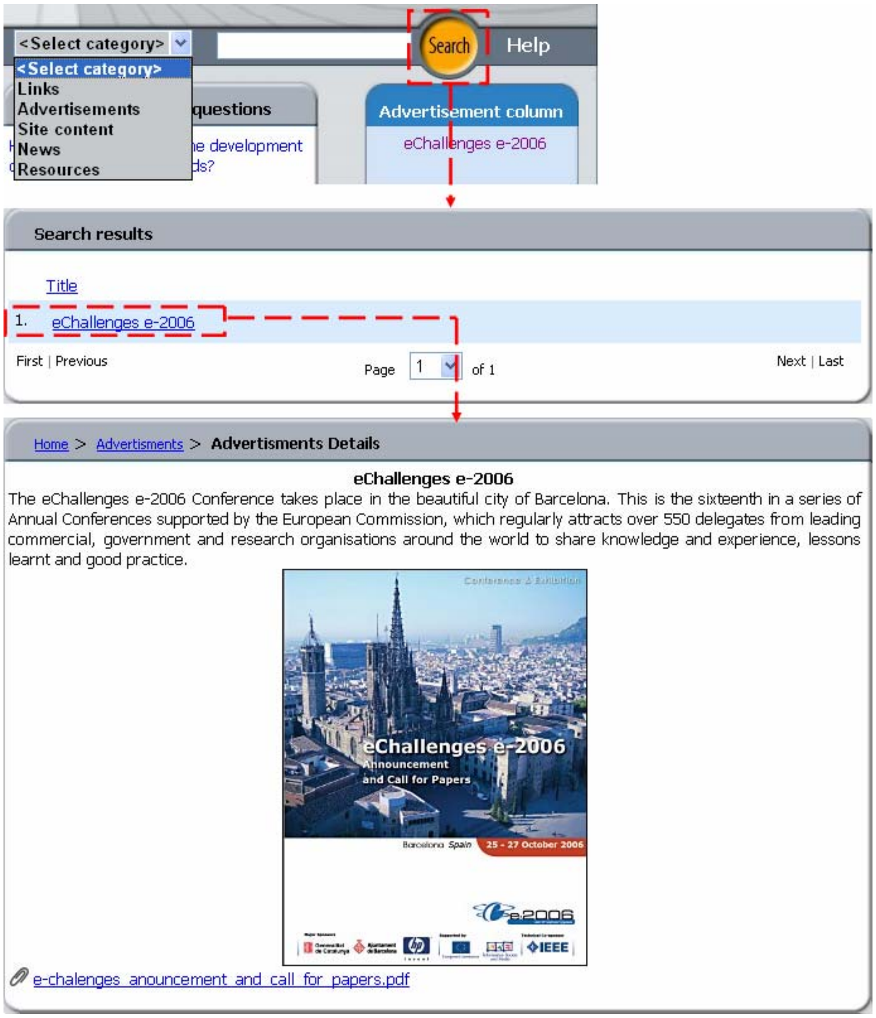


Figure 6:4: Using the search facility

6.2.2.2 Registration

The registration process is achieved in two distinct ways according to the potential role assignment, either using the portal registration mechanism or after invitation by the portal administrator. Users that apply for registration using the portal registration mechanism can select among the following role assignments:

ExEs
GSEs

- Simple users

On the other hand, users invited by the portal administrator can be assigned one of the following roles:

- NMC members

- NMC Leader
- WGLs
- WGMs
- IPs
- FPs
- SIG moderators

6.2.2.2.1 Public registration process

Users that wish to participate in the portal as knowledge consumers, ExEs or GSEs can access the registration mechanism through the register button contained in the "New to this site?" widget. The registration mechanism requires the provision of input regarding the account, personal and contact information. Additionally, the preferred role assignment must be selected. The registration process is completed upon confirmation of the aforementioned information. The overall process is presented in Figure 6:5.

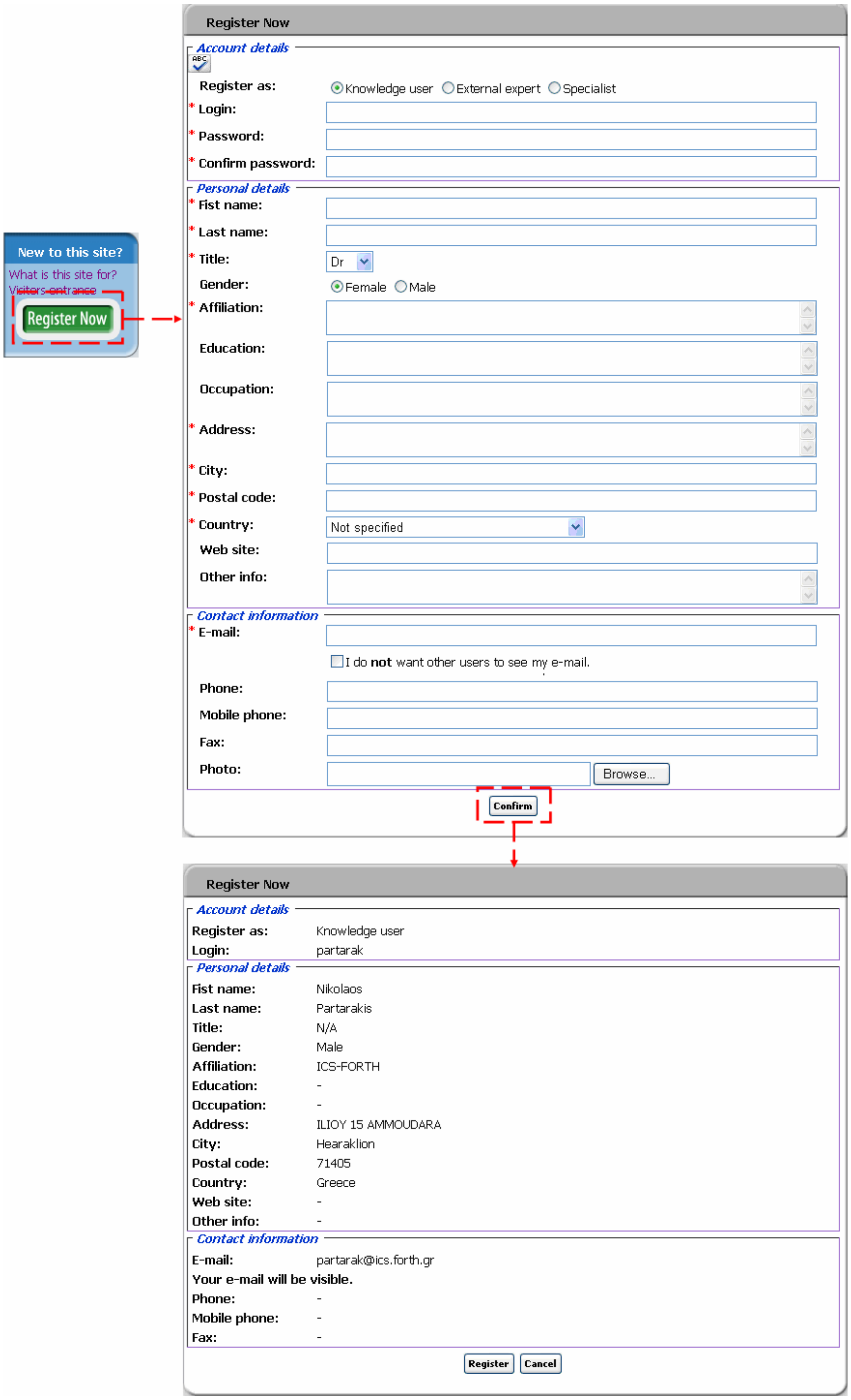


Figure 6:5: Public registration process

6.2.2.2.2 Registration by Portal administrator

The interface provided to portal administrators for the subscription of new users is displayed in Figure 6:6. To perform a registration, the administrator has to provide the account information, the role assignment and the SIGs or WGs subscriptions of the new participant.

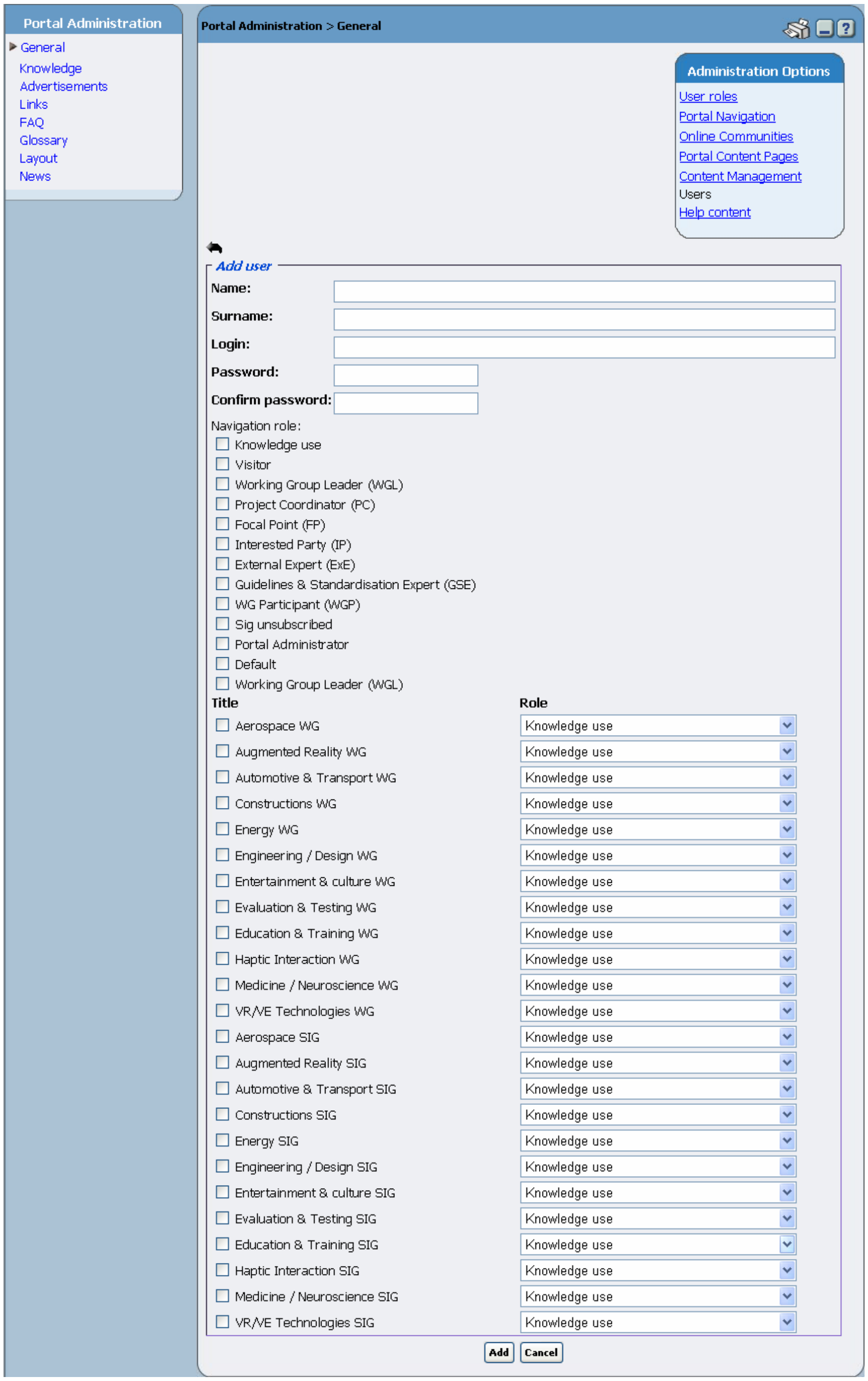


Figure 6:6: Registration by the portal administrator

6.2.2.3 News & Announcements

From this area, site visitors can gain access to news and announcements regarding VR guidance and standardisation in Europe. This widget provides the latest three items, enabling quick access to the most up to date information. The selection of “view all news& announcements” link displays all available items. The details of a specific item are accessed through its selection from one of the aforementioned interfaces. The process described for browsing News & Announcements is presented in Figure 6:7.

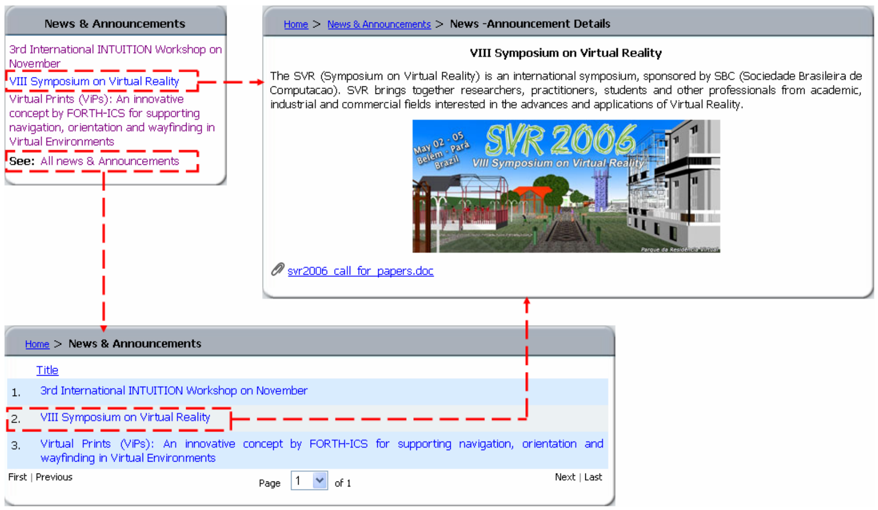


Figure 6:7: Browsing News & Announcements

6.2.2.4 New items

The New items widget displays the latest three publications representing the outcome of the INTUITION work on guidelines and standards. The full list of new items is displayed using the “view all new items” link. The selection of an item from the aforementioned interfaces navigates to the resource details page were only the basic metadata of each resource are displayed. Access to the full version of a resource is gained only upon subscription to the portal and only from the registered user’s area. The overall process of browsing new items is presented in Figure 6:8.

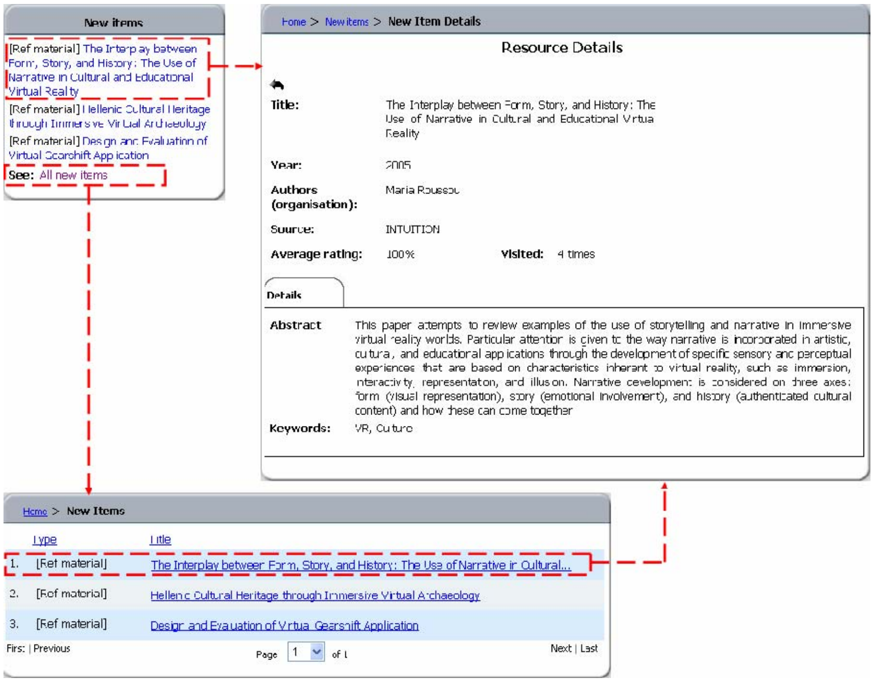


Figure 6:8: Browsing New items

6.2.2.5 Popular items

From this area, visitors of the site can access information about the three most popular publications. This feature provides social navigation to resources, enabling access to the basic metadata about resources that have the highest user rating. The list of all popular items is accessed through selection of the “see all popular items” link. The process of browsing popular resources is presented in Figure 6:9.

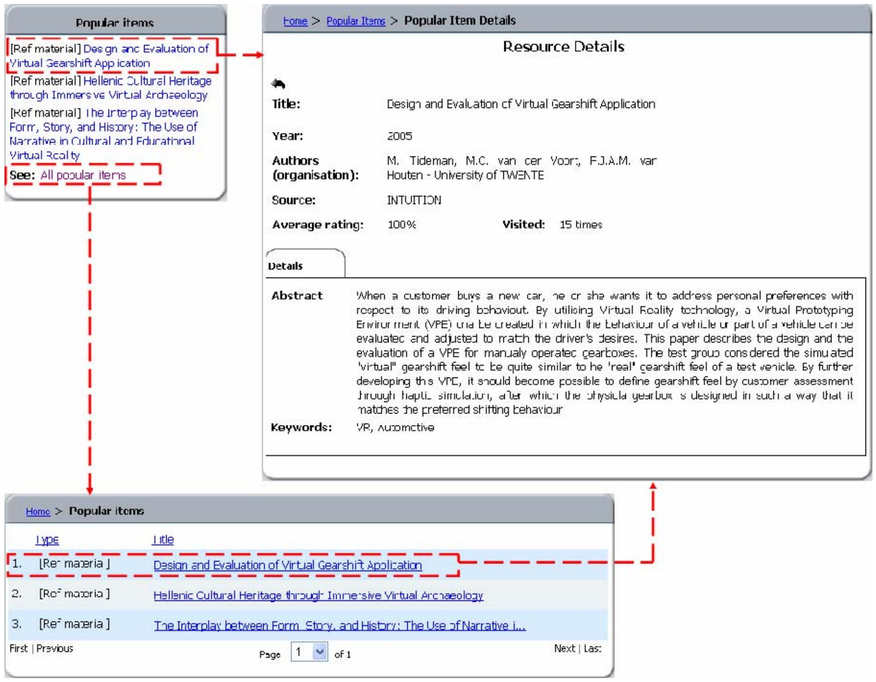


Figure 6:9: Browsing popular items

6.2.2.6 Frequently asked questions

In this area the latest three Frequently Asked Questions are presented, together with the option to view the full list of available questions through the selection of the "see all frequently asked questions" link. Access to the contents of a Frequently Asked Question is gained upon its selection from the aforementioned interfaces. The overall process is presented in Figure 6:10.

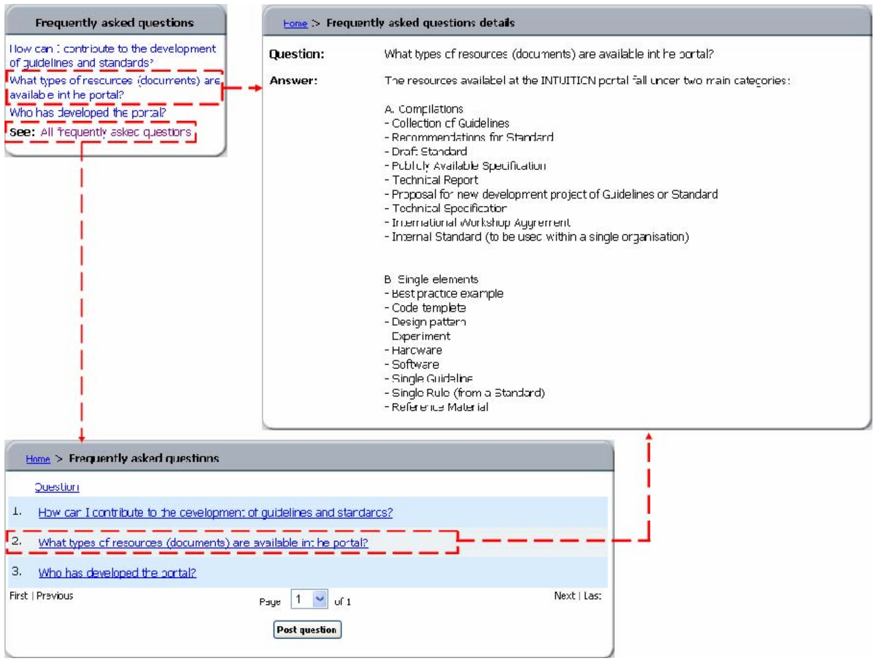


Figure 6:10: Browsing Frequently Asked Questions

Additionally, the submission of new questions is possible by filling in the form presented in Figure 6:11. Submitted questions are answered by portal administrators either by making the question submitted and the answer provided available online or by posting a personal reply via e-mail.

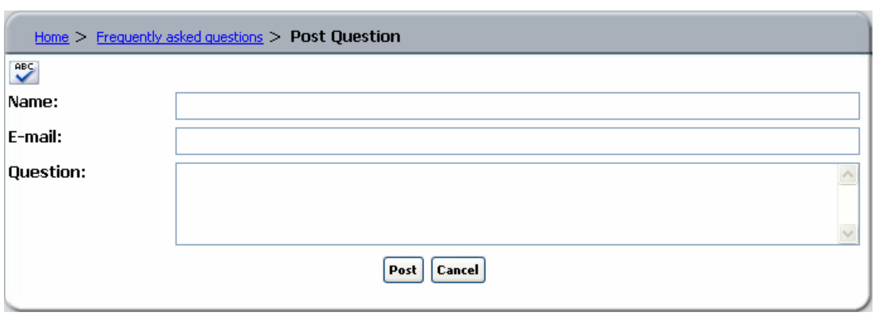


Figure 6:11: Submission of a new Frequently Asked Question

6.2.2.7 Links

This interface displays the three most recent links to policy makers, standardisation bodies, etc. The selection of the “see all links” link displays the full list of available links in paging mode. The link detailed view interface is accessed through the selection of a link from the aforementioned interfaces. The process of browsing links is presented in Figure 6:12.

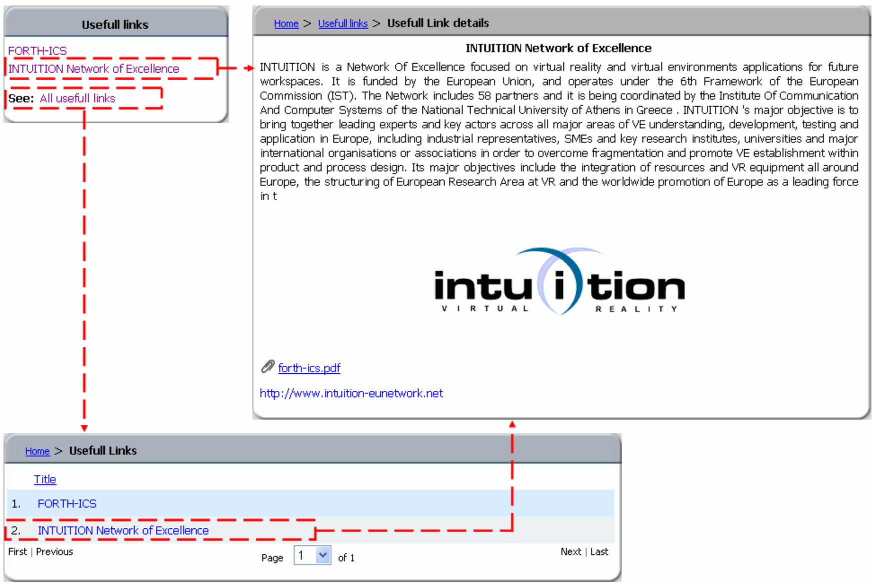


Figure 6:12: Browsing links

6.2.2.8 Statistics

Through this area, the site visitors can access figures and statistics regarding guidance documents published by INTUITION, users of the portal, and running activities. The statistics widget displays the five categories available for browsing namely:

1. Publications
2. Users
3. Brainstorming
4. Proposals
5. Projects

6.2.2.8.1 Publications

Publications statistics provide an overview of the resources published in the digital library in relation to the available resource types as shown in Figure 6:13. The same information is provided in a pie chart diagram where each resource type is displayed with a different colour in the chart. For each resource type, a label is displayed in the right side of the chart presenting the type’s name and the percentage of published items of the specific type in relation to the whole number of items.

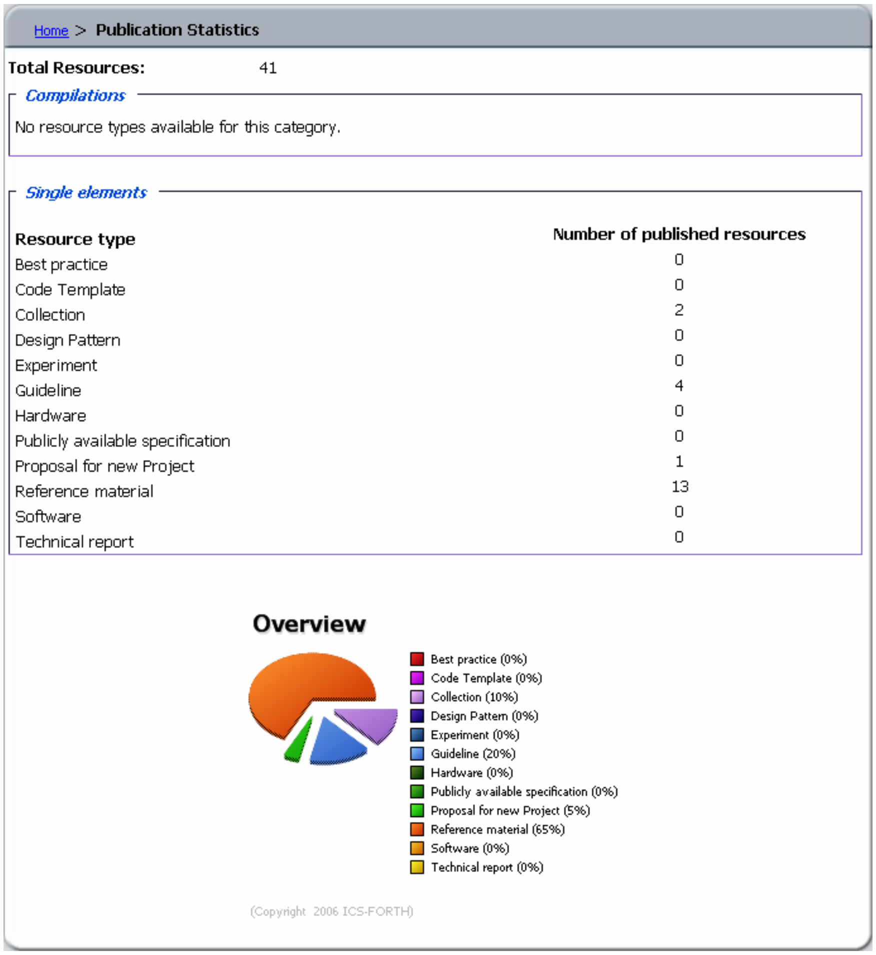


Figure 6:13: Publication statistics

6.2.2.8.2 Users

This section provides an overview of the users accessing the portal according to their role as shown in Figure 6:14. More specifically, the following sections can be identified:

- **Visitors:** Provides an overview of the users that either accessed the public area of the portal or entered as visitors in order to get a glimpse of the available services and interface.
- **Knowledge consumers:** Provides an overview of the subscribed knowledge consumers and the number of knowledge datasets available for subscription.
- **Knowledge developers:** Displays the number of users participating to the development of knowledge in relation to their role assignment.
- **External contributors:** Provides an overview of the users participating as external contributors and therefore assigned with the role of ExE or GSE.

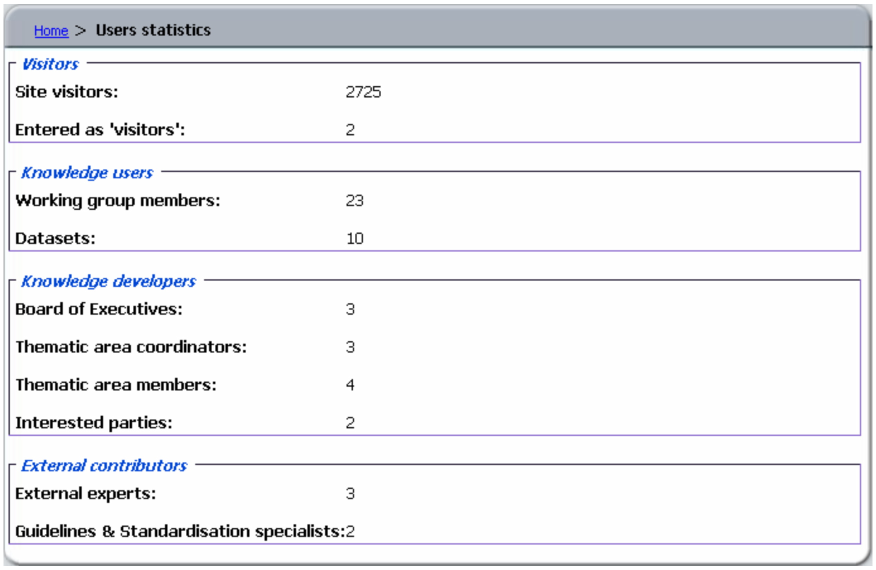


Figure 6:14: Users' statistics

6.2.2.8.3 Brainstorming

This category of statistics (Figure 6:15) provides an overview of the brainstorming sessions for each WG in relation to their completion status. The same information is displayed in two different collective forms as a pie chart and as a bar chart:

- The pie chart presents all sessions from all WGs in relation to their completion status.
- The bar chart displays the sum of brainstorming sessions for each WG.

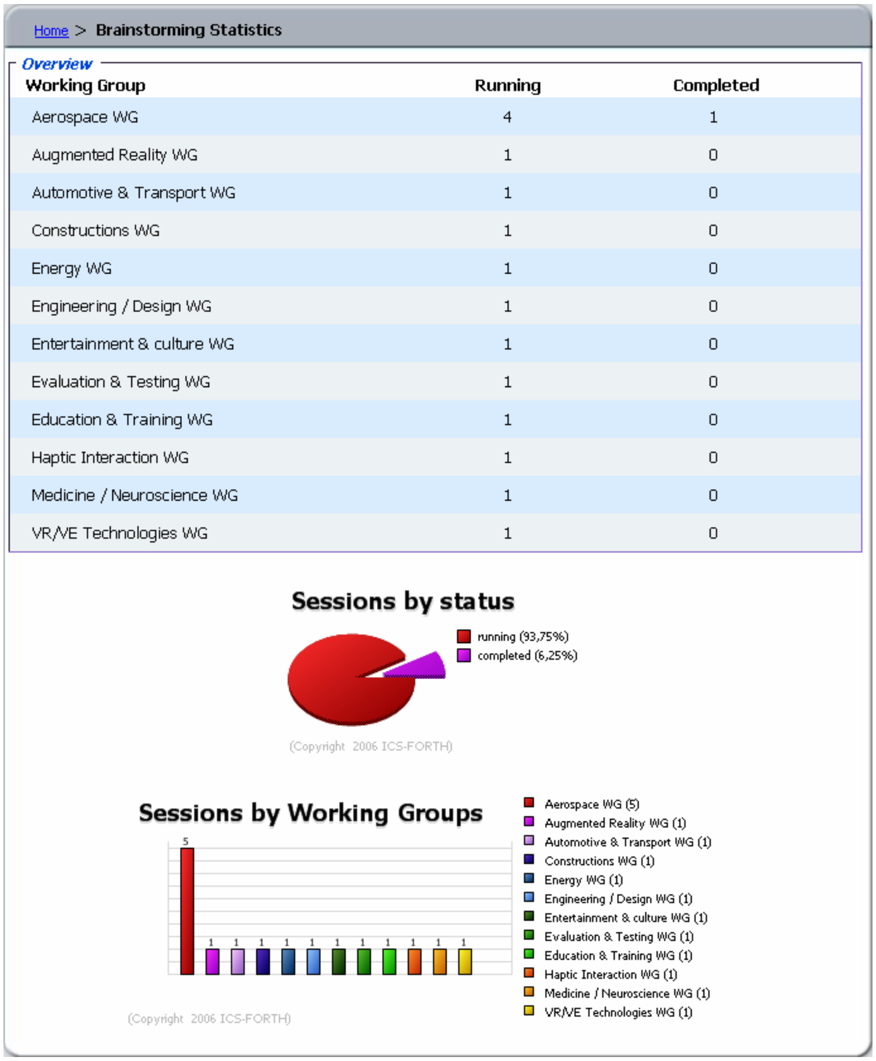
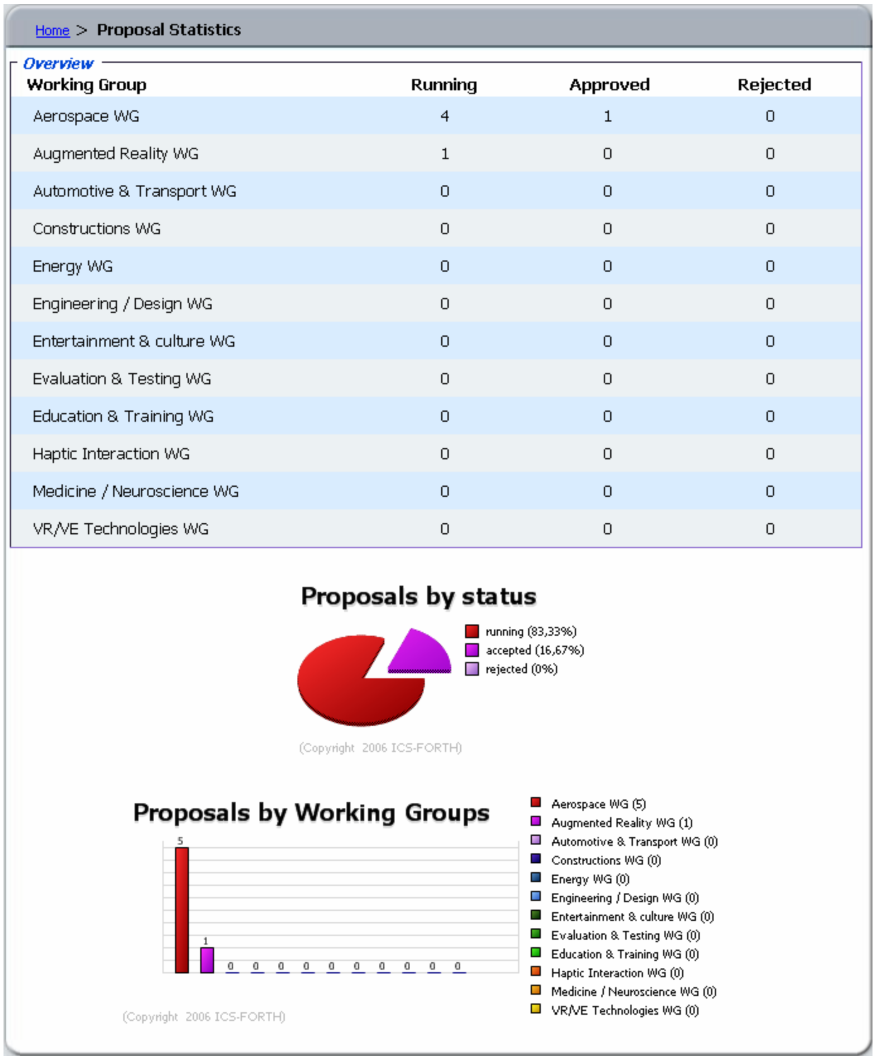


Figure 6:15: Brainstorming statistics

6.2.2.8.4 Proposals

This category of statistics (Figure 6:16) provides an overview of the proposals held in each WG in relation to their completion status. The same information is displayed in two different collective forms as a pie chart and as a bar chart:

- The pie chart presents all the proposals from all WGs in relation to their completion status.
- The bar chart displays the sum of proposals for each WG.



Home > Proposal Statistics

Overview

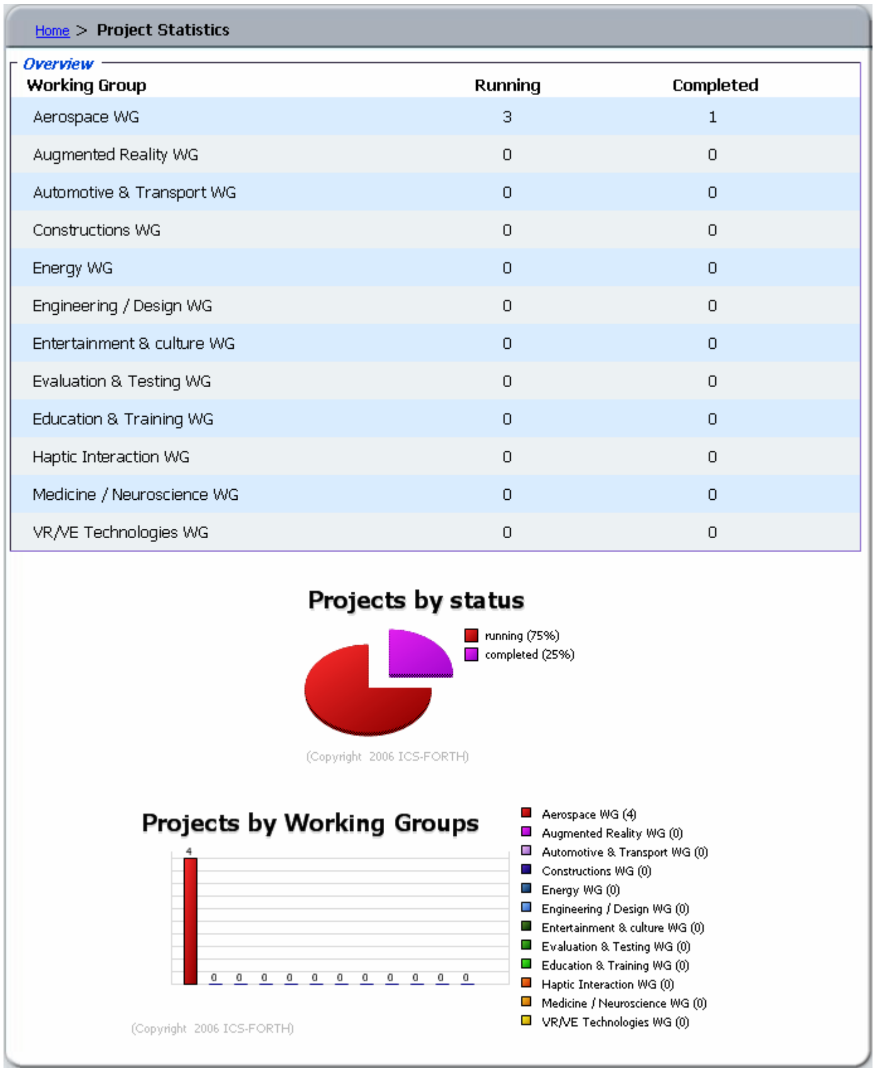
Working Group	Running	Approved	Rejected
Aerospace WG	4	1	0
Augmented Reality WG	1	0	0
Automotive & Transport WG	0	0	0
Constructions WG	0	0	0
Energy WG	0	0	0
Engineering / Design WG	0	0	0
Entertainment & culture WG	0	0	0
Evaluation & Testing WG	0	0	0
Education & Training WG	0	0	0
Haptic Interaction WG	0	0	0
Medicine / Neuroscience WG	0	0	0
VR/VE Technologies WG	0	0	0

Figure 6:16: Proposals statistics

6.2.2.8.5 Projects

This category of statistics (Figure 6:17) provides an overview of the projects held in each WG in relation to their completion status. The same information is displayed in two different collective forms as a pie chart and as a bar chart:

- The pie chart presents all the projects from all WGs in relation to their completion status.
- The bar chart displays the sum of projects for each WG.



Home > Project Statistics

Overview

Working Group	Running	Completed
Aerospace WG	3	1
Augmented Reality WG	0	0
Automotive & Transport WG	0	0
Constructions WG	0	0
Energy WG	0	0
Engineering / Design WG	0	0
Entertainment & culture WG	0	0
Evaluation & Testing WG	0	0
Education & Training WG	0	0
Haptic Interaction WG	0	0
Medicine / Neuroscience WG	0	0
VR/VE Technologies WG	0	0

Figure 6:17: Project statistics

6.2.2.9 Advertisements

The advertisements section aims at promoting individual work of INTUITION partners. This section displays the three most recent advertisements and provides access to the full list of advertisements through the “see all advertisements link”. The detailed advertisement view is accessed through selection of an advertisement from the aforementioned interfaces. The overall process of browsing advertisements is presented in Figure 6:18.

Figure 6:18: Browsing advertisements

6.2.2.10 Glossary

The glossary provides access to acronyms definitions and abbreviations of terms that are of importance or relevance to the activities of INTUITION regarding VR guidance and Standardisation in Europe. The submission of a search query using the glossary widget leads to the results page responsible shown in Figure 6:19.

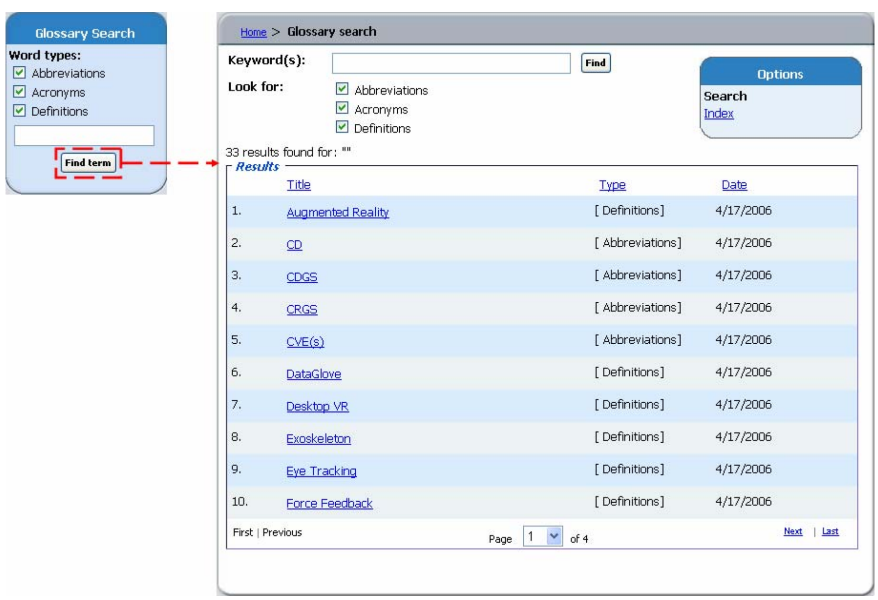


Figure 6:19: Finding terms using the glossary module

6.2.3 Knowledge consumers

As already stated, different users have access to different views of the portal in term of presentation functions and navigation styles. Knowledge consumers are assigned the general view of the portal presented in Figure 6:20. The main areas of interest are:

1. Resources
2. Special interest groups
3. Additional Functionality

Figure 6:20: The layout assigned to knowledge consumers

In the following sections, each of these main navigation categories is described in depth.

6.2.3.1 <u>Resources</u>

This widget provides alternative ways of navigation to the INTUITION publications. The different navigation alternatives are:

- **Categories:** Category-based browsing

- **Search:** Keyword-based browsing
- **Under Public review:** Items published for public review
- **Top rated items:** Browsing based on users' rating
- **Most popular items:** Browsing based on popularity
- **All items:** Browsing based on the subscribed knowledge datasets

6.2.3.2 Categories

The categories navigation option provides access to resources according to a number of different categorizations, as shown in Figure 6:21.

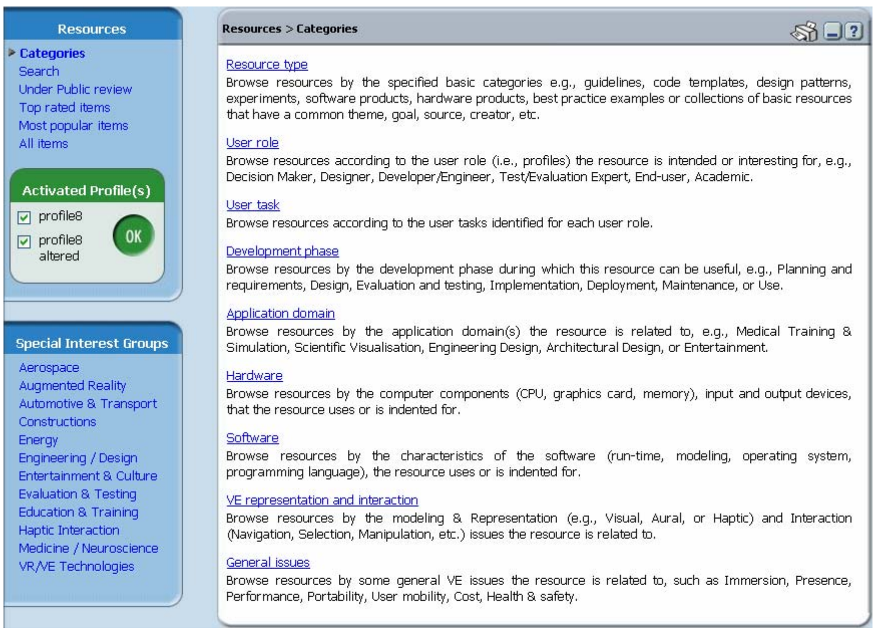


Figure 6:21: The interface displaying the available categories for browsing

The different available categorisations of resources are:

Resource type: Browse resources by the specified basic categories, e.g., guidelines, code templates, design patterns, experiments, software products, hardware products, best practice examples or compilations of basic resources that have a common theme, goal, source, creator, etc. The interface provided for selection among the different resource types is displayed in Figure 6:22.

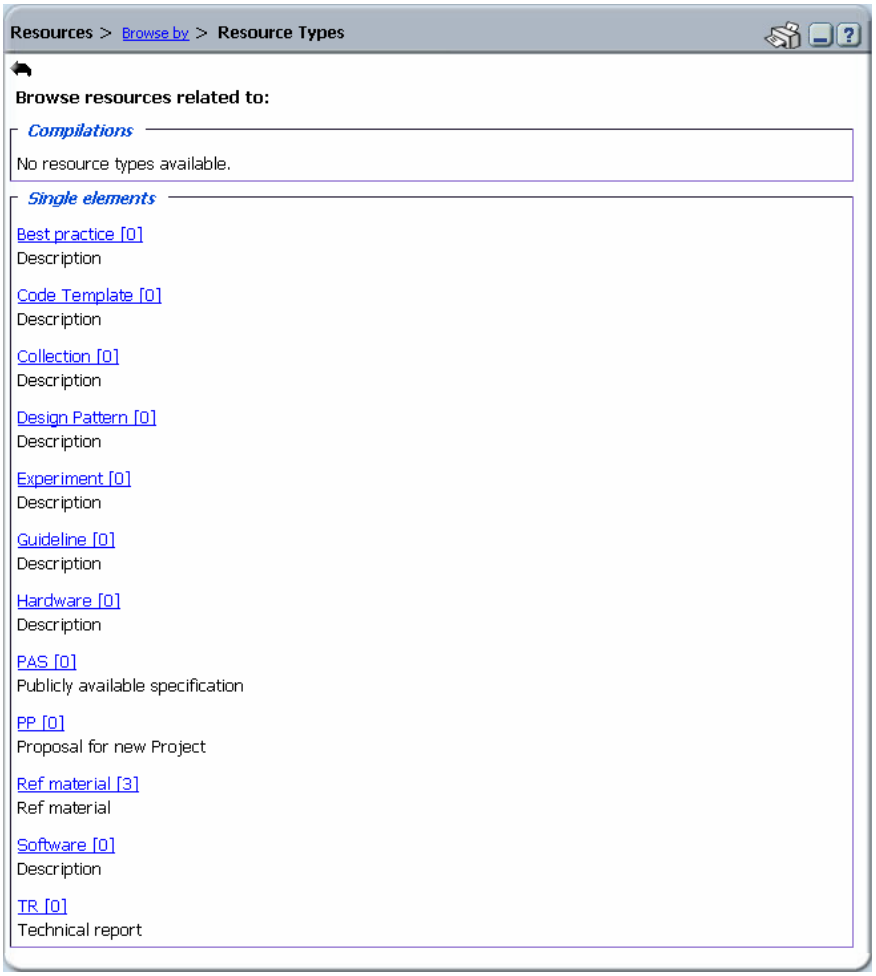


Figure 6:22: The resource type selection interface

User role: Browse resources according to the user role the resource is intended or interesting for, e.g., Decision Maker, Designer, Developer/Engineer, Test/Evaluation Expert, End-user and Academic. The interface provided for selection among the different user roles is displayed in Figure 6:23.

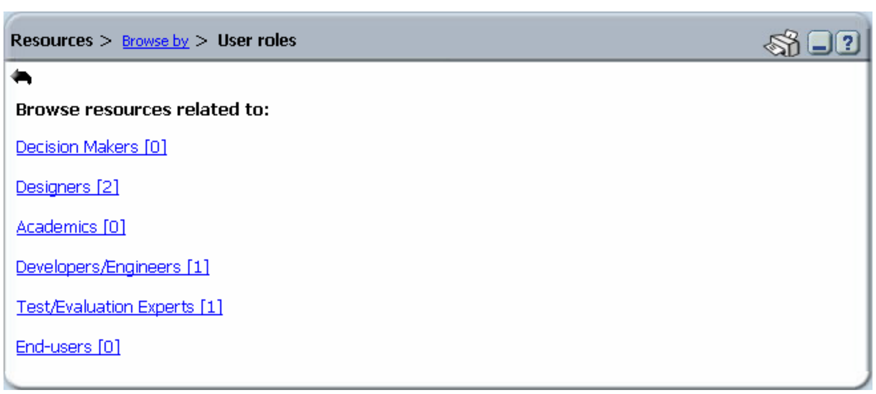


Figure 6:23: The user role selection interface

User task: Browse resources according to the user tasks identified for each user role. The interface provided for selection among the different user tasks is displayed in Figure 6:24.

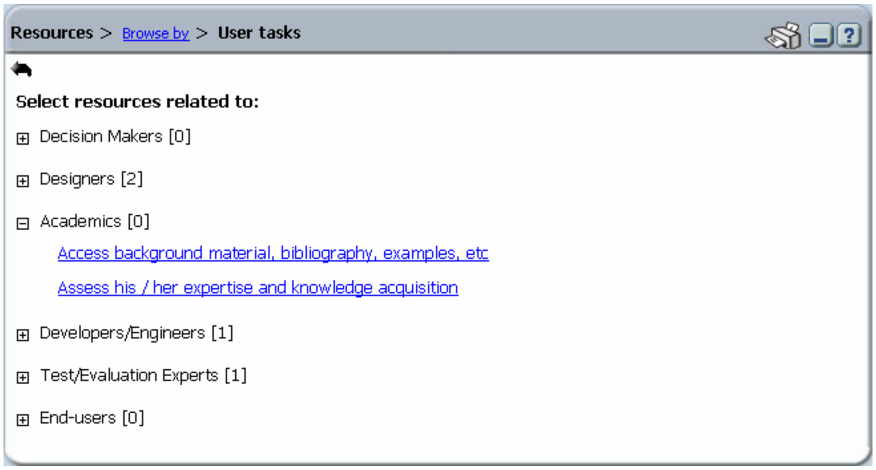


Figure 6:24: The user task selection interface

Development phase: Browse resources by the development phase during which this resource can be useful, e.g., Planning and requirements, Design, Evaluation and testing, Implementation, Deployment, Maintenance, or Use. The interface provided for selection among the different development phases is displayed in Figure 6:25.

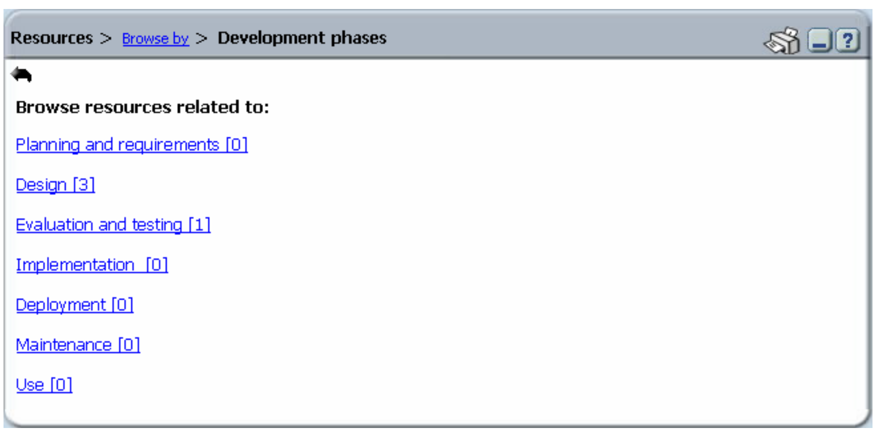


Figure 6:25: The development phase selection interface

Application domain: Browse resources by the application domain(s) the resource is related to, e.g., Medical Training & Simulation, Scientific Visualisation, Engineering Design, Architectural Design, or Entertainment. The interface provided for selection among the different application domains is displayed in Figure 6:26.

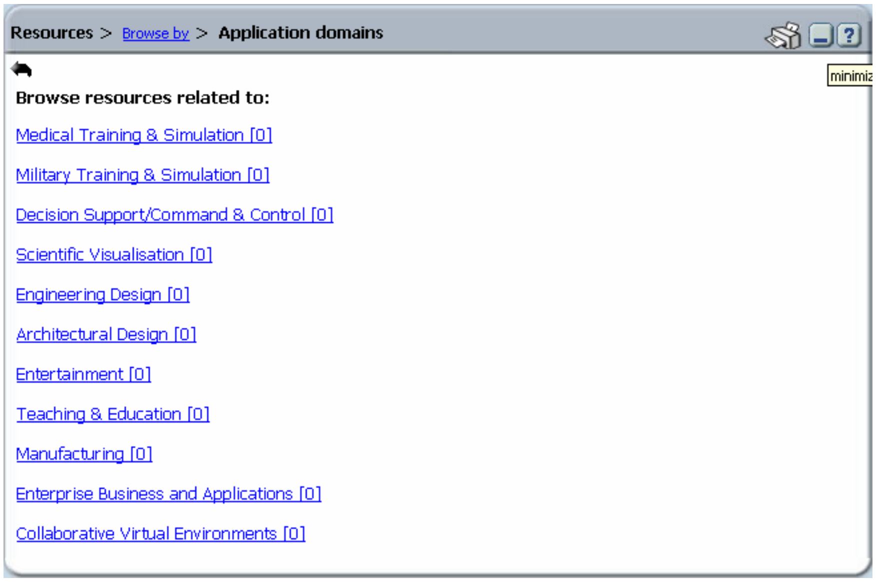


Figure 6:26: The application domain selection interface

Hardware: Browse resources by the computer components (CPU, graphics card, memory), input and output devices, that the resource uses or is indented for. The interface provided for selection among the different hardware setups is displayed in Figure 6:27.

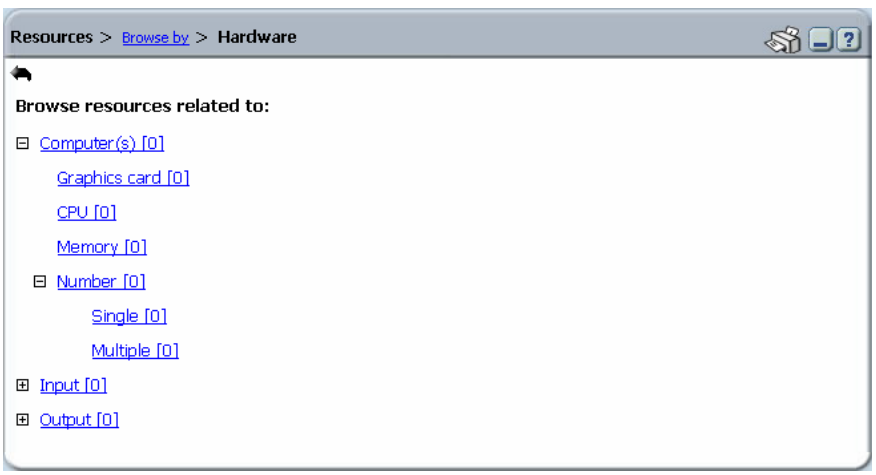


Figure 6:27: The hardware hierarchy selection interface

Software: Browse resources by the characteristics of the software (run-time, modelling, operating system, programming language), the resource uses or is indented for. The interface provided for selection among the different software categories is displayed in Figure 6:28.

Figure 6:28: The software hierarchy selection interface

VE representation and interaction: Browse resources by the modelling & Representation (e.g., Visual, Aural, or Haptic) and Interaction (Navigation, Selection, Manipulation, etc.) issues the resource is related to. The interface provided for selection among the different types of VE representations and interactions is displayed in Figure 6:29.

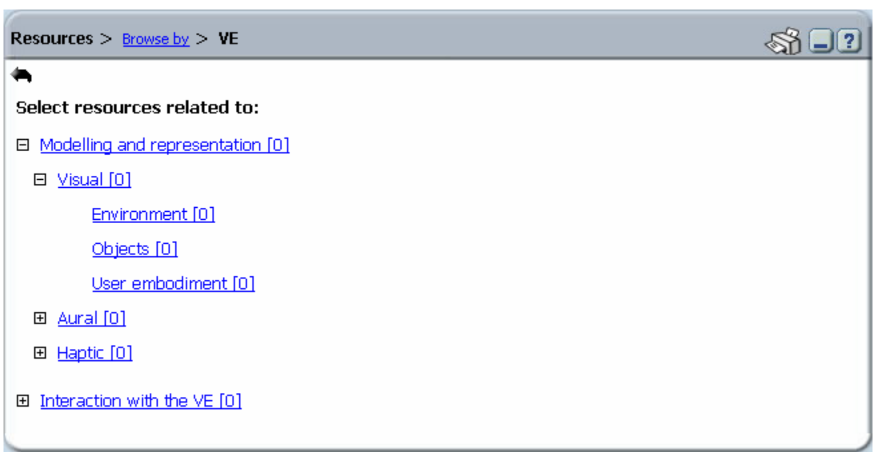


Figure 6:29: The VE representation and interaction selection interface

General issues: Browse resources by some general VE issues the resource is related to, such as Immersion, Presence, Performance, Portability, User mobility, Cost, Health & safety. The interface provided for selection among the different issues is displayed in Figure 6:30.

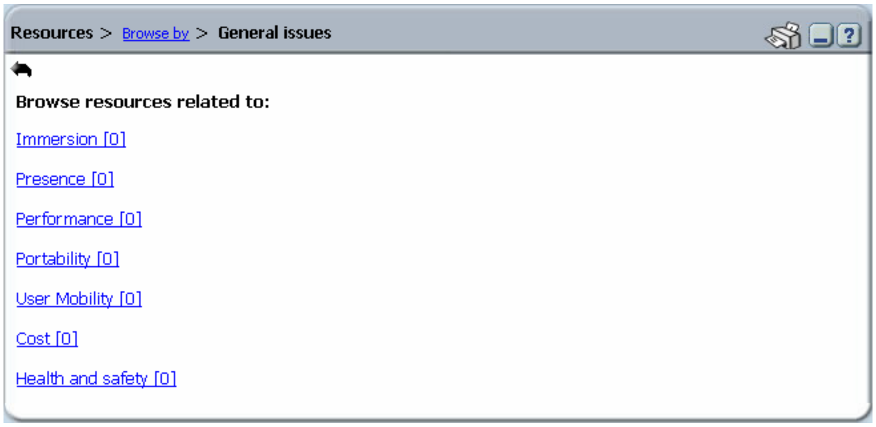


Figure 6:30: The general issues selection interface

6.2.3.3 Search

Thought the search interface, users can perform a keyword-based search on the documents contained in the digital library. Two different search variations are provided, and namely:

- **Simple search:** Simple search enables users to quickly search resources based only on a search query and additional search variations. These variations affect the strictness that the search string will be used. The simple mode of the search interface is presented in Figure 6:31.

Figure 6:31: The simple version of the search interface

- **Advanced search:** Advanced search enables users to select among additional options, such as the resource types to be contained in the results, the rating of the resources to be retrieved and the publication date. Figure 6:32 displays the advanced mode of the search interface.

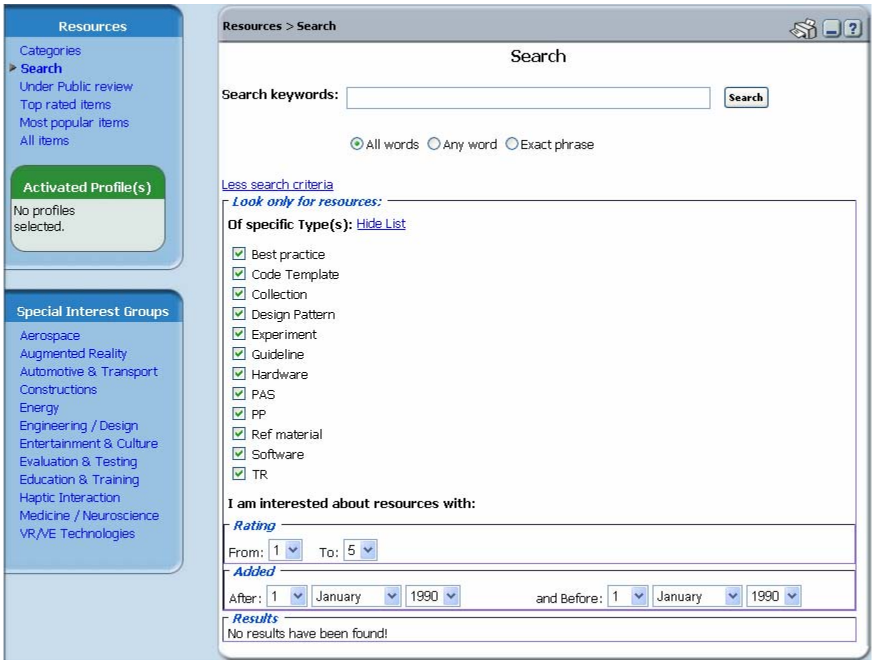


Figure 6:32: The advanced version of the search interface

6.2.3.4 Under public review

From this navigation option knowledge consumers access the results of standardisation activities submitted (in the form of draft reports) to the digital library for public review. The public review phase of a project aims at gathering comments from the actual users of the project report. These comments are subsequently used in order to draft the final project report. The interface displaying the resources under public review shown in Figure 6:34 provides additional information, such as the project title the WG in which the report is developed and the time period of the review.

Figure 6:33: Resources under public review

The selection of a report from the aforementioned list displays the contents of the report as shown in Figure 6:34.

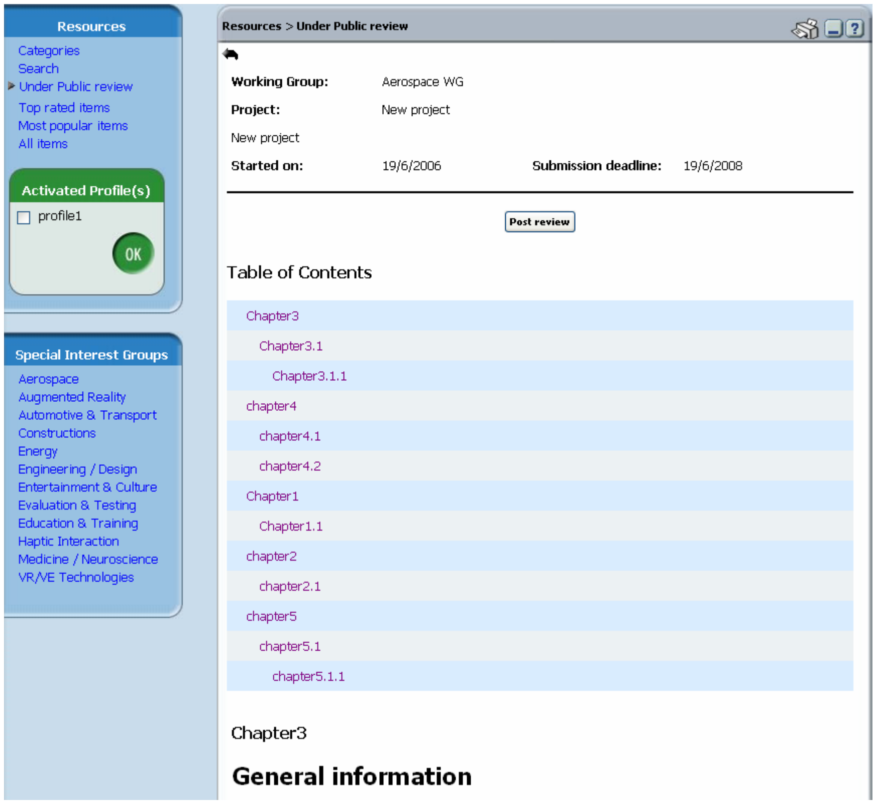


Figure 6:34: The content of a report under public review

Users can read the report and submit their comment using the reviewing interface shown in Figure 6:35.

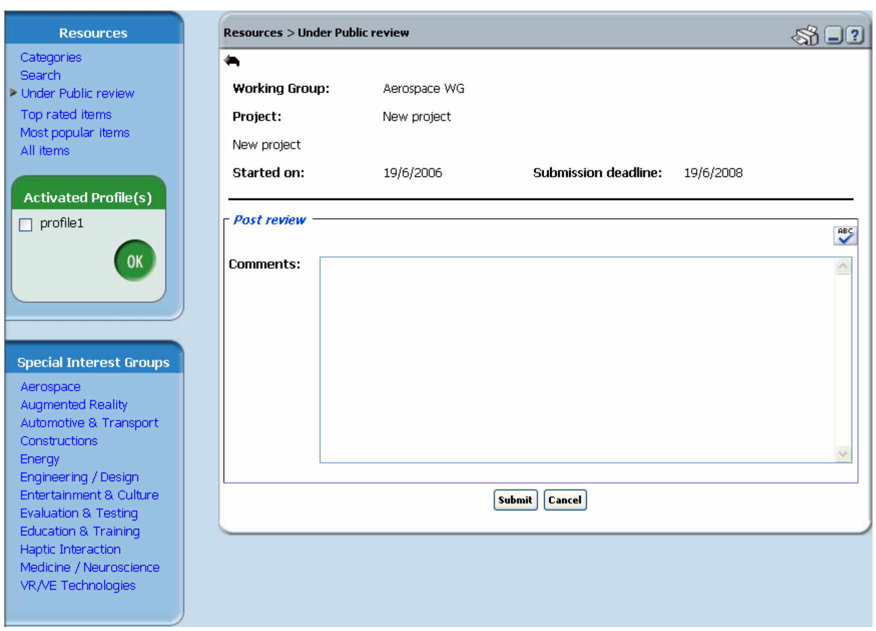


Figure 6:35: Posting a review on resource content

6.2.3.5 Social navigation

Social navigation is the processes of using cues from other people for finding information based on the fact that when people are searching information in various spaces often rely on other people advice rather than more formal tools. Towards this direction two measurement criteria were used for providing social navigation to resources popularity and rating.

6.2.3.5.1 Top rated resources

Through this navigation option, users of the portal can access resources that have the highest rating among portal users, as shown in Figure 6:36.

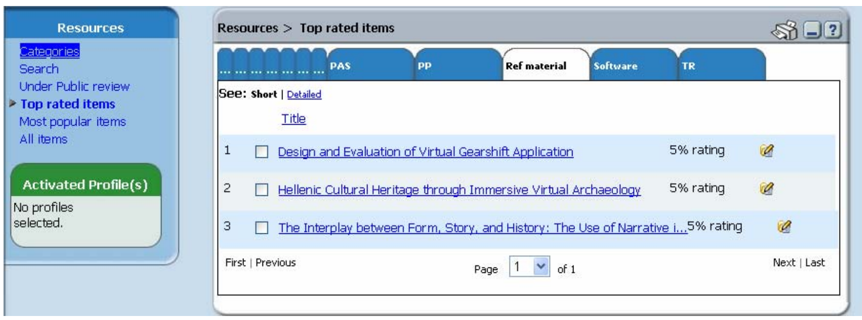


Figure 6:36: The interface displaying resources based on users' rating

6.2.3.5.2 Most popular resources

Through this navigation option users of the portal can access resources based on the number of times that each resource of the digital library is visited, as shown in Figure 6:37.

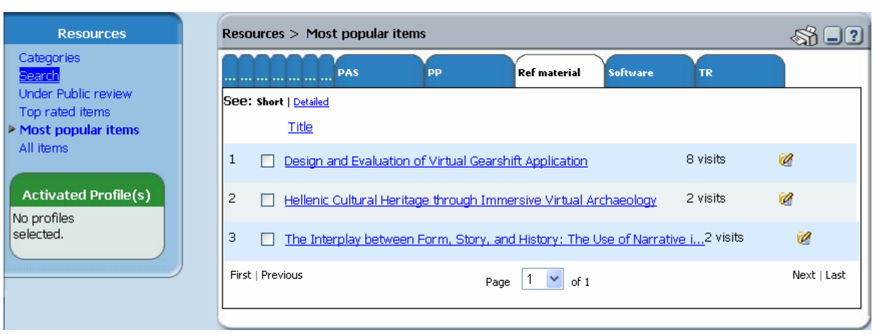


Figure 6:37: The interface displaying resources based on popularity

6.2.3.6 All items

This navigation option provides to knowledge consumers the option to browse resources based on the subscribed collections of knowledge. The initial interface of this feature displays all the knowledge datasets contained in the system as shown in Figure 6:38. The user subscribed datasets are displayed as links and all the other collections as labels. For each unsubscribed collection, the option to post a subscription request is provided.

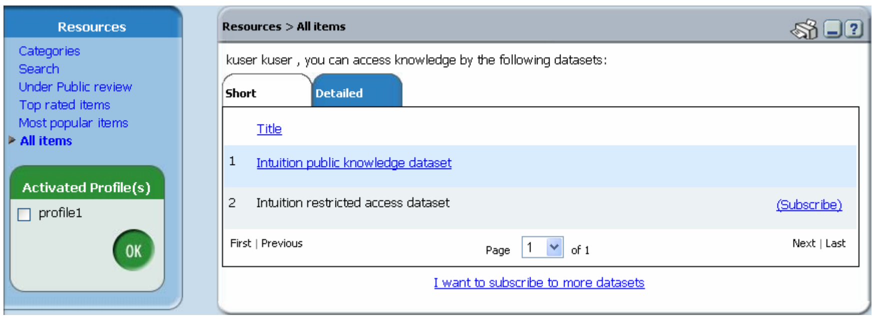


Figure 6:38: The interface displaying all knowledge datasets.

The selection of a collection from the aforementioned list displays its contents. The interface shown in Figure 6:39 is organised in tabs, each of which represents the resources of a specific resource type contained in the dataset.

Figure 6:39: The contents of a dataset

6.2.3.7 Resource details

The resource details interface provides access to the actual content and functionality of a resource. This interface, shown in Figure 6:40, can be divided into three main areas, and namely:

- Resource details
- Actual content and additional information
- Resource options

Figure 6:40: The resource details view

6.2.3.7.1 Resource details

Provide general information such as title, authors' publication date, source etc. This information need to be visible during navigation to the tabs containing the actual content of the resource for consistency. In this way the currently browsed publication can be easily identified through all the additional content interfaces.

6.2.3.7.2 Actual content and additional information

The tabs identified in Figure 6:40 display the actual content of the resource and provide additional information such as user reviews, related items etc. The collection of tabs used for the presentation of this information varies according to the characteristics of the resource type. Each resource type during its creation is connected with a number of information categories and information fields that are subsequently used in order to adapt the resource details interface to the characteristics of the specific resource.

6.2.3.7.3 Resource options

The basic functions that a user can perform on a resource are:

- **Rate resource:** The collection of user ratings is important for the provision of social navigation to resources. The rating of a resource based on a scale from one to five provides useful information to all knowledge consumers in order to easily identify the publications that seem to be widely accepted. The interface used to gather user rating is displayed in Figure 6:41.

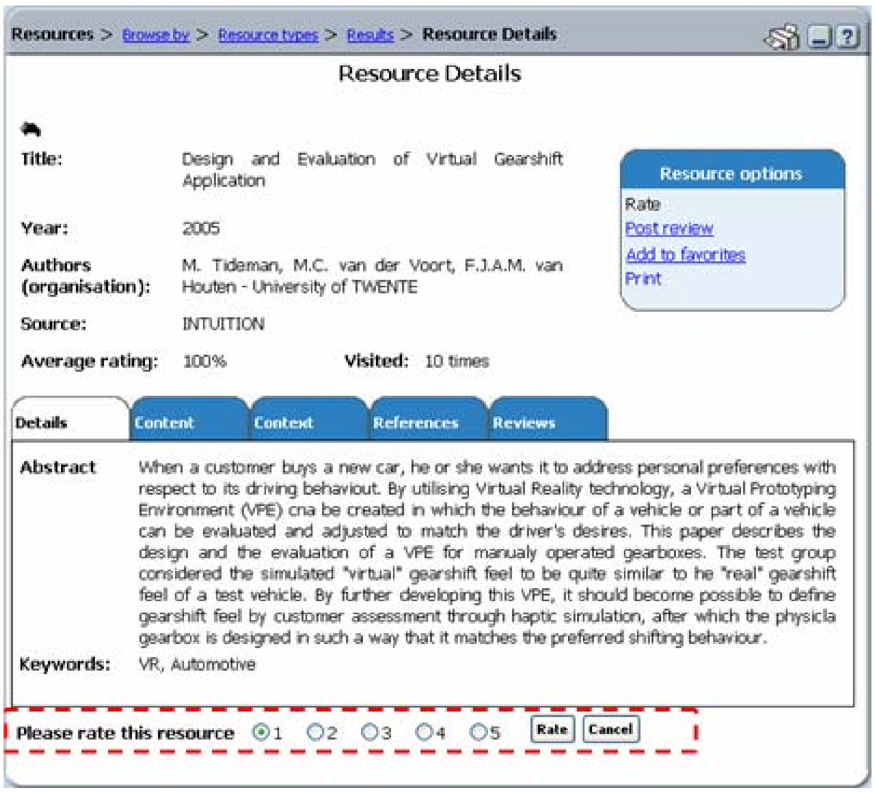


Figure 6:41: The rate resource function

- **Post review:** Reviews are used for providing feedback to resource authors and can be used to improve the quality of a publication. The form used for submitting a review on a publication is shown in Figure 6:42.

Figure 6:42: The post review interface

- **Add to favourites:** This enables users to add bookmarks to resources of personal interest for quick browsing. These bookmarks are manipulated through the favourite's component described in detail in section 6.2.3.8.
- **Print resource**: This function provides access to the printable version of a resource generated by the appropriate manipulation of all the available resource metadata and additional material. An example of a printable version of a resource is displayed in Figure 6:43.

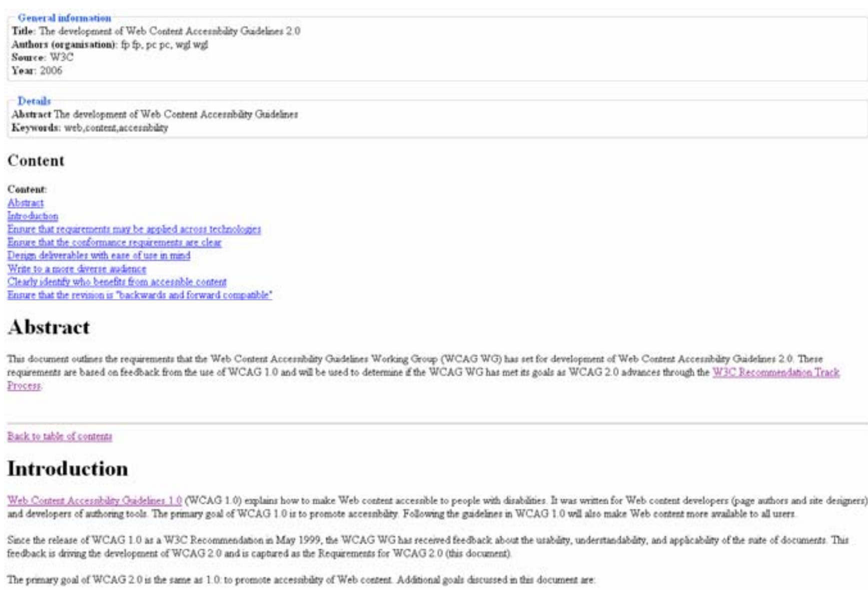


Figure 6:43: The printable version of a resource

6.2.3.8 Favourites

The favourite's component provides the option to maintain personal bookmarks on publications of the digital library. Bookmarks can be organised in a file system like hierarchy of folders. Each folder can contain a number of sub-folders or bookmarks as shown in Figure 6:44.

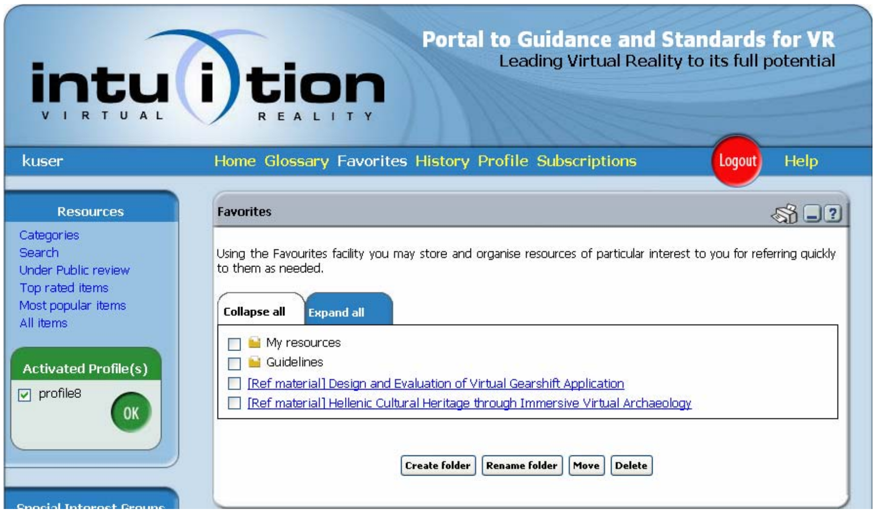


Figure 6:44: The favourite's initial interface

The main functions provided by the favourite's component are:

- **Create folder:** The creation of a folder entails the selection of the parent folder in the case of a subfolder or simply the selection of this function in the case of a root folder. The create folder interface requires the provision of a folder name for completing the creation.
- **Rename folder(s):** The process of renaming a number of folders is initiated by the selection of the folders to be renamed and the subsequent selection of the "rename folder" option from the functions bar. The rename folder interface requires the provision of a new name for each item to be renamed.
- **Move item:** Moving folders or bookmarks is accomplished by the selection of the items to be moved and the subsequent selection of the "move item" option from the functions bar. The interface provided for moving items requires the provision of a new parent for the items to be moved.
- **Delete item(s):** Deleting items is carried out by the selection of the items to be deleted and the subsequent selection of the "delete" option from the functions bar.

The overall functionality provided by the favourite's functionality is presented in Figure 6:45.

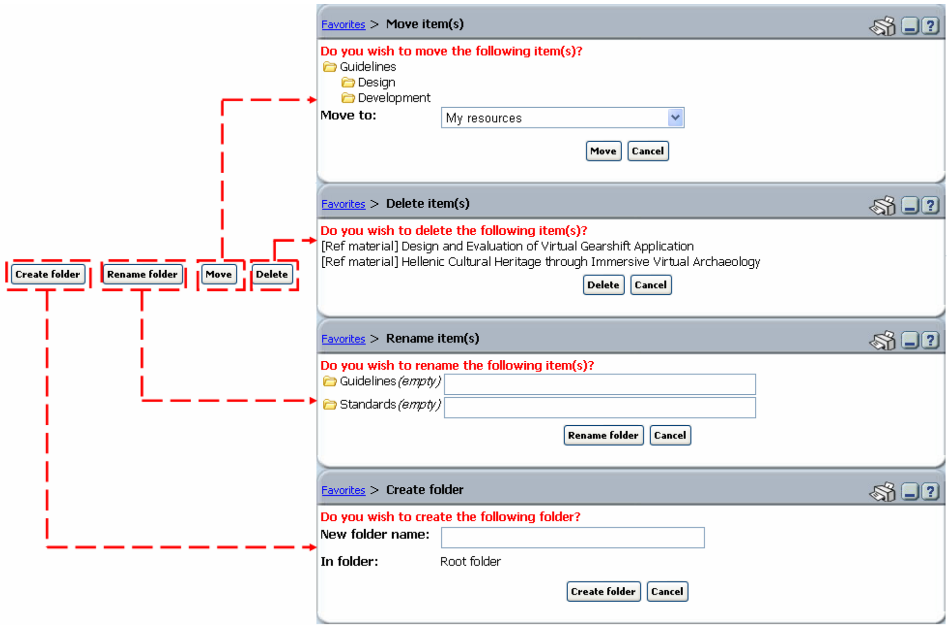


Figure 6:45: Overview of favourite's functionality

Add items: During resource browsing, bookmarks on publications can be added to favourites using the build in functionality provided by the resource details interface. A resource added in the favourite's component is shown in the root folder of the favourites file system. This item can in turn be moved to a folder of the favourites work area.

6.2.3.9 History

The history component provides the ability to keep history information about all the resources browsed thought the digital library. The functions that can be performed using this component are:

- **Browse resources based on resource type:** This interface contains a number of tab pages representing the user preferences regarding the resource types that history information shall be recorded as shown Figure 6:46. The selection of a tab displays a list of resources browsed and the date accessed.
- **Edit history settings:** History settings affect the resource types that portal keeps history information and the duration that these information are valid. The interface provided for editing the history settings is shown in Figure 6:47.

Figure 6:46: The browse history interface

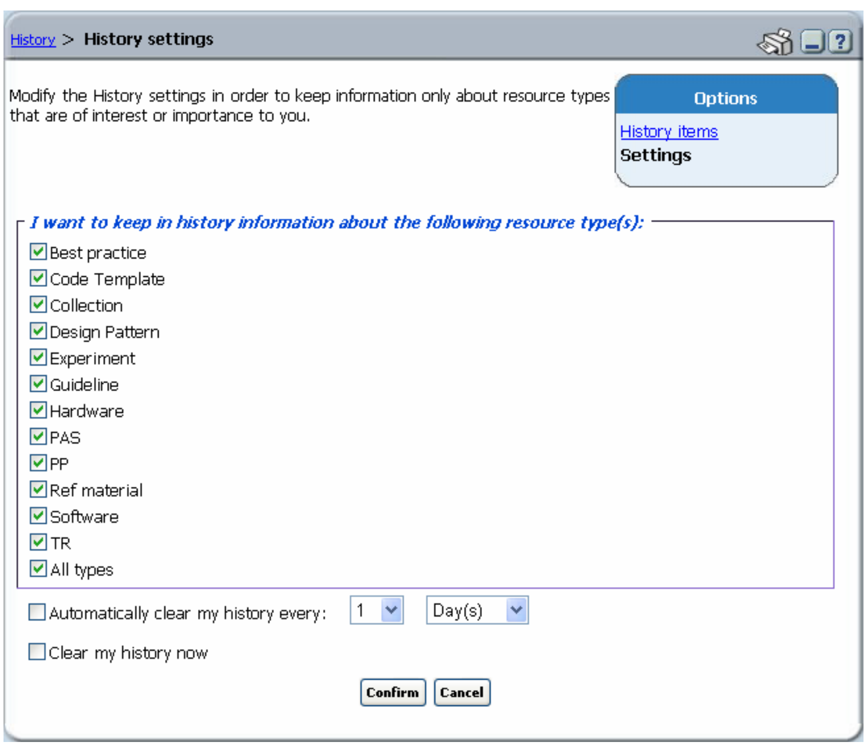


Figure 6:47: The edit history settings interface

6.2.3.10 Profile

In this area, users can access all the personal information maintained by the system for personalisation purposes. Two different categories of profiles are available that can be accessed through the following profile options:

Personal details: This feature offers access to the personal information submitted during registration as shown in Figure 6:48.

Figure 6:48: The user profile interface

This interface also provides the option to edit this information using the interface shown in Figure 6:49.

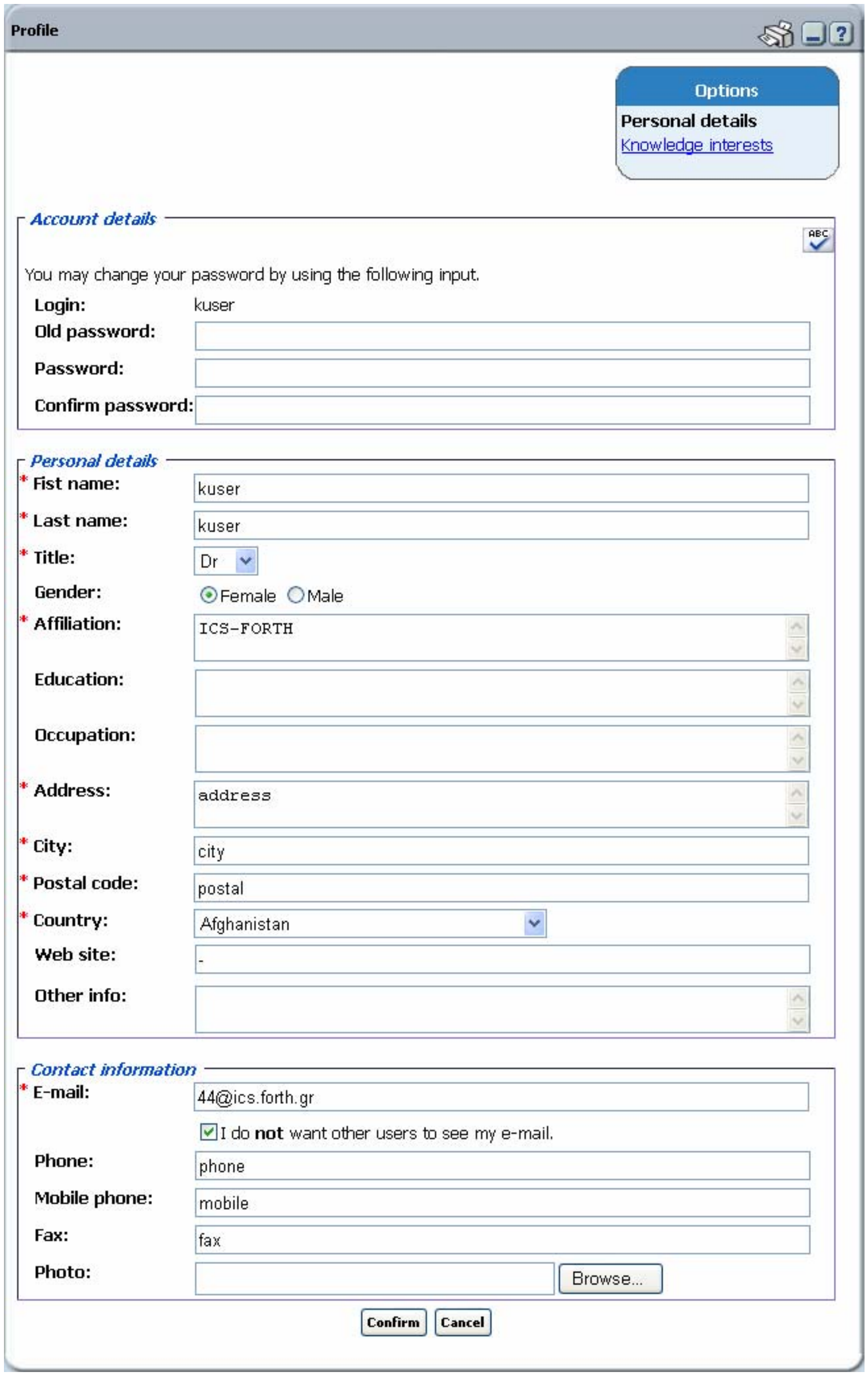


Figure 6:49: The edit user profile interface

Knowledge interests: These profiles help users to eliminate the search and browse results down to specific Area (s) of Interest identified. The profiles selected by each user are displayed in the profiles window presented in Figure 6:50.

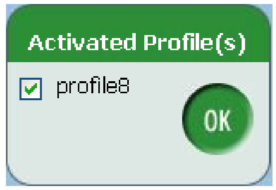


Figure 6:50: The activated profiles widget

The knowledge interests' interface is organized in two sections:

- **The predefined profiles:** This interface displays a list of profiles that are build- in to the system and represent the basic areas of interest identified by the requirements analysis phase. Users are provided with the following options (Figure 6:51):
  - **Activate profiles:** By activating a profile the search and browse results are filtered based on this profile.
  - **Deactivate profiles:** Deactivating a profile means that this profile doesn't affect the search and browse result any more.
  - **Remove profiles:** Deselecting a profile means that this profile doesn't appear in the users activated profiles window and cannot be enabled or disabled at run time.
  - **Personalize profiles:** The personalisation of profiles enables users to alter already existing profiles in order to adapt them to their own preferences. Personalised profiles are displayed by the created profiles section.

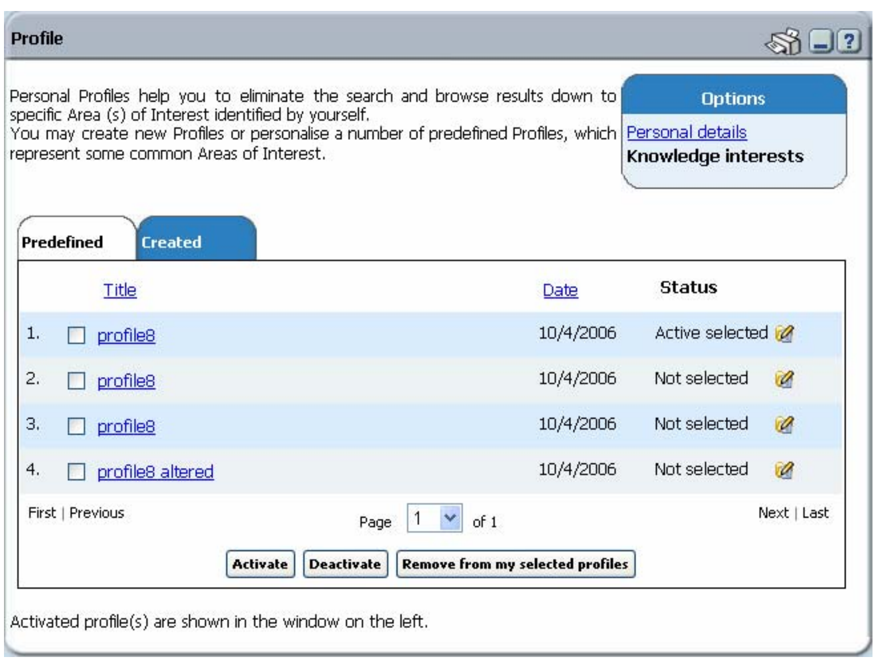


Figure 6:51: The predefined profiles

- **The created profiles:** This interface provides a list of all the personalized profiles of a user as shown in Figure 6:52. The options provided by this interface are:
    - o **Activate profiles**
    - o **Deactivate profiles**
    - o **Delete profiles:** Deleted profiles are removed from the created profiles list.

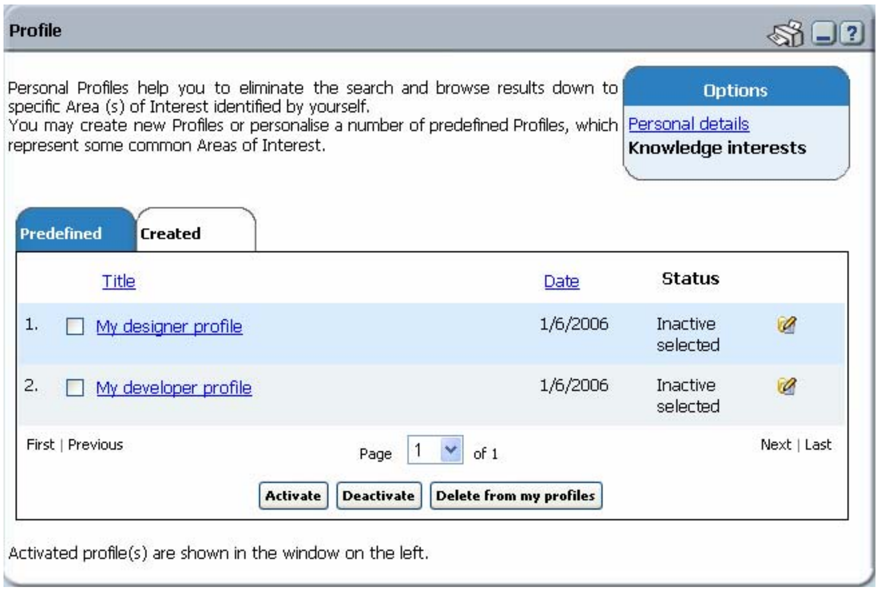


Figure 6:52: The created (personalised) profiles

6.2.3.11 <u>Subscriptions</u>

The subscriptions facility provides access to the portal services and items that are based on restricted access (need registration). The basic options provided for subscription are:

- Special interest groups
- Knowledge collections

6.2.3.11.1 Special interest groups

Through this interface, shown in Figure 6:53, personal subscriptions to SIGs can be administrated. SIGs are online communities of users that share similar goals, interests, needs, or activities that provide the primary reason for belonging to the community. Each special interest group provides functionality for asynchronous communication, synchronous communication and document sharing.

Figure 6:53: Special Interest Groups Subscriptions

The "Special Interest Groups" subscriptions interface provides three different tabs representing:

- **Subscribed SIGS:** This tab displays the SIGs currently subscribed. From this area existing subscriptions to SIGs can be cancelled.
- **Unsubscribed SIGS:** This tab displays the SIGs available for subscription, enabling the submission of new subscription requests. The SIGs requested for subscription become available through the SIGs navigation widget only upon acceptance of these requests by the SIG moderator.
- **Pending subscription requests:** This tab provides access to the submitted subscription requests, enabling the cancellation of requests.

6.2.3.11.2 Knowledge collections

The knowledge collections option provides access to all the collections of knowledge (datasets) available for subscription, as shown in Figure 6:54.

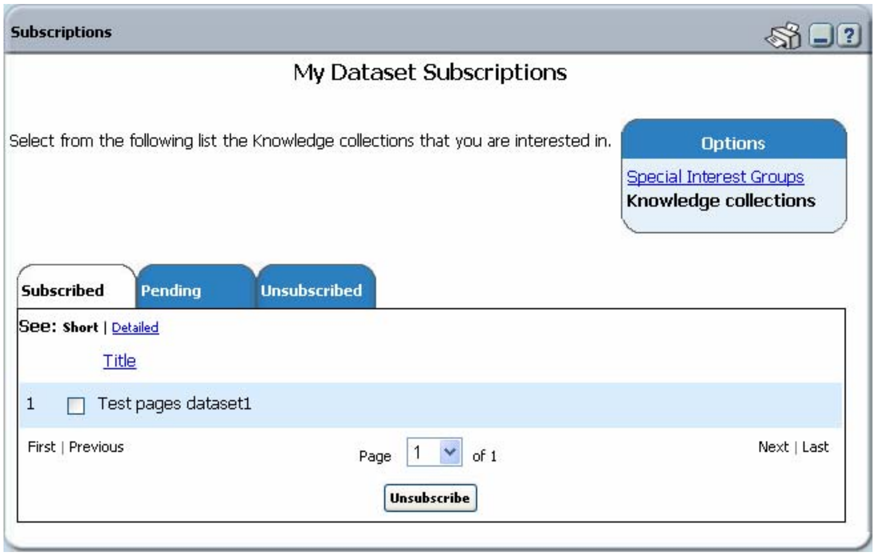


Figure 6:54: The Knowledge collections subscriptions

These collections are organized into three basic categories:

- **Subscribed collections:** From the subscribed collections the option to cancel a subscription to a dataset is provided. By cancelling a subscription, the resources contained in this dataset are no longer be accessible through the different resource browsing facilities provided by the portal.
- **Unsubscribed collections:** From the unsubscribed collections new subscription requests can be submitted. The resources contained in these knowledge collections become visible only upon acceptance of these subscriptions by the portal administrator.
- **Pending subscription requests:** Through this option, the collections for which a subscription request is pending are displayed. From this interface already existing subscription requests can be cancelled.

6.2.4 Visitors

Users entering as visitors' access the same interface layout provided to knowledge consumers, as shown in Figure 6:55. The functionality provided is strictly for demonstrative reasons in order for these users to obtain an overview of the layout and functions provided to actual participants. Therefore, many areas and functions of the actual interface are not visible. More specifically, as shown in Figure 6:55, the personal areas such as profiles, subscriptions, history, and favourites are not available. Additionally, only the resources contained in the public knowledge dataset can be accessed through the resources widget, and only the SIGs descriptions can be viewed from the Special Interest Groups widget.

Figure 6:55: The visitor view of the portal

6.2.5 Knowledge developers

Users participating in the development of knowledge have access to a different interface layout from the knowledge consumers, as shown in Figure 6:56.

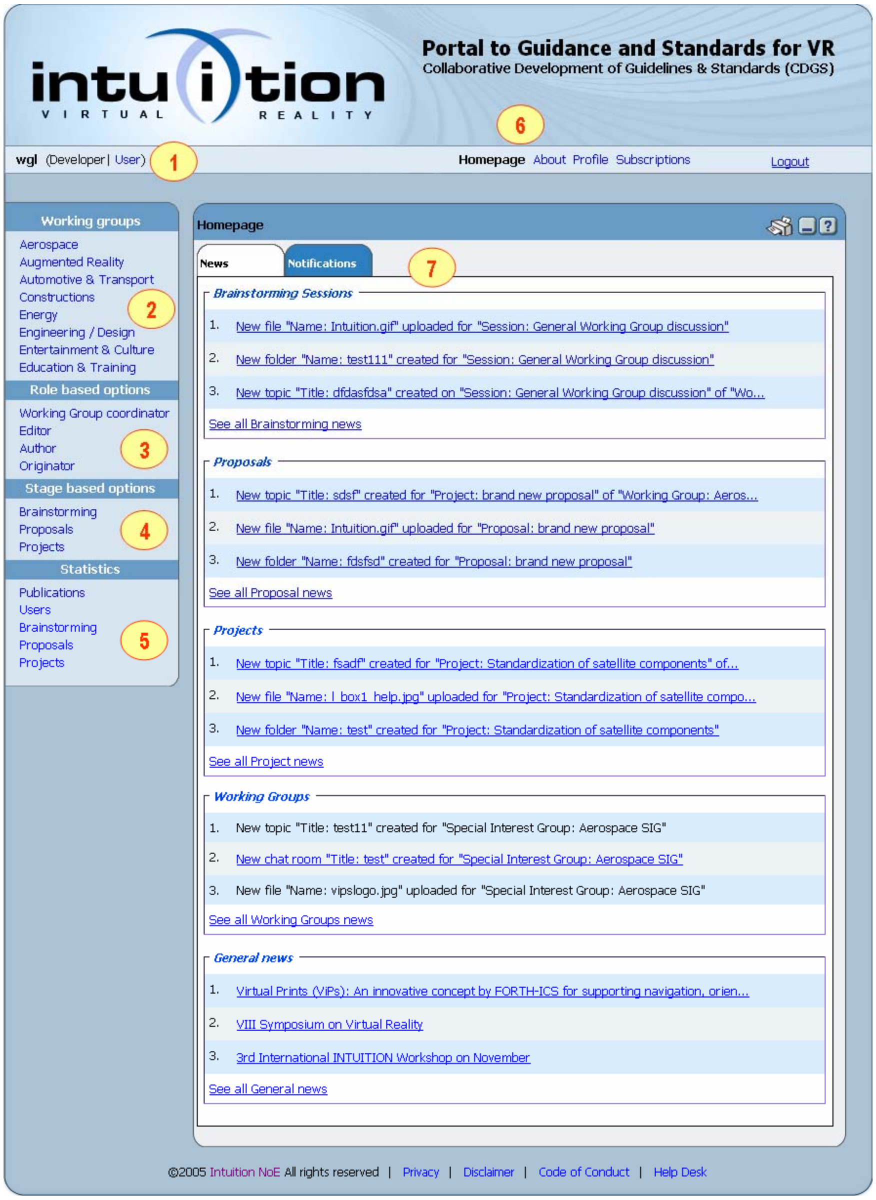


Figure 6:56: The developers' view of the portal

The main areas of interest in this page are:

1. **The role - layout switching bar**
2. **Working Groups**
3. **Role based options**
4. **Stage based options**
5. **Statistics regarding knowledge development and use**
6. **Additional functionality**
7. **News & Notifications**

In the following sections, each of these main areas of interest is described in depth.

6.2.5.1 Role - layout switching bar

Users developing knowledge have also the possibility to access the traditional knowledge consumer layout and navigation hierarchy through the layout switching bar. Selecting the user's view, the developer layout is unloaded and the user layout is loaded. This transition also alters the navigation hierarchy and displays the consumer's view of the portal. Therefore, developers participate in the portal with two roles in terms of navigation and layout. The one is used for the development of knowledge and the other for accessing knowledge. The overall process is presented in Figure 6:57.

Figure 6:57: Switch roles and layout using the Role-layout switching bar

6.2.5.2 Working Groups

All the activities aiming at the development of Guidance and Standards are organized in a number of WGs. Each WG has different views according to the role assignment of the user accessing it. Figure 6:58 presents the full version of a WG accessed by users with roles WGL, WGM, NMC Leader and FP.

Figure 6:58: The full version of a WG

On the other hand, Figure 6:59 presents the reduced version of a WG accessed by users with roles ExE and GSEs.

Figure 6:59: The cut-down version of a WG

6.2.5.2.1 WG overview

This option provides information and statistics about the WG and can be divided into three main sections, as shown in Figure 6:60:

1. **WG Description:** Provides a brief introduction about the scope and objectives of the WG.
2. **Users:** Displays information about the participants of the WG with the following categorization:
    a. **Knowledge developers:** Contains the users participating as knowledge developers to the activities of the WG.
    b. **External contributors:** Contains the users participating to the WG activities as ExEs or GSEs.
    c. **Overview:** Displays a graphical representation in a pie chart of all the WG users according to their role assignment.

3. **Standardisation activities:** Displays the activities of the WG. More specifically, the following areas can be recognised:
    a. **Brainstorming sessions:** Displays all the session organised in the WG in relation to their completion status.
    b. **Proposals:** Contains all the proposal of the WG according to their completion status.
    c. **Projects:** Contains all the projects of the WG in relation to their completion status.
    d. **Activities overview:** Provides a graphical representation of the total number of activities taking place for each of the three main steps needed to generate a CDGS report.

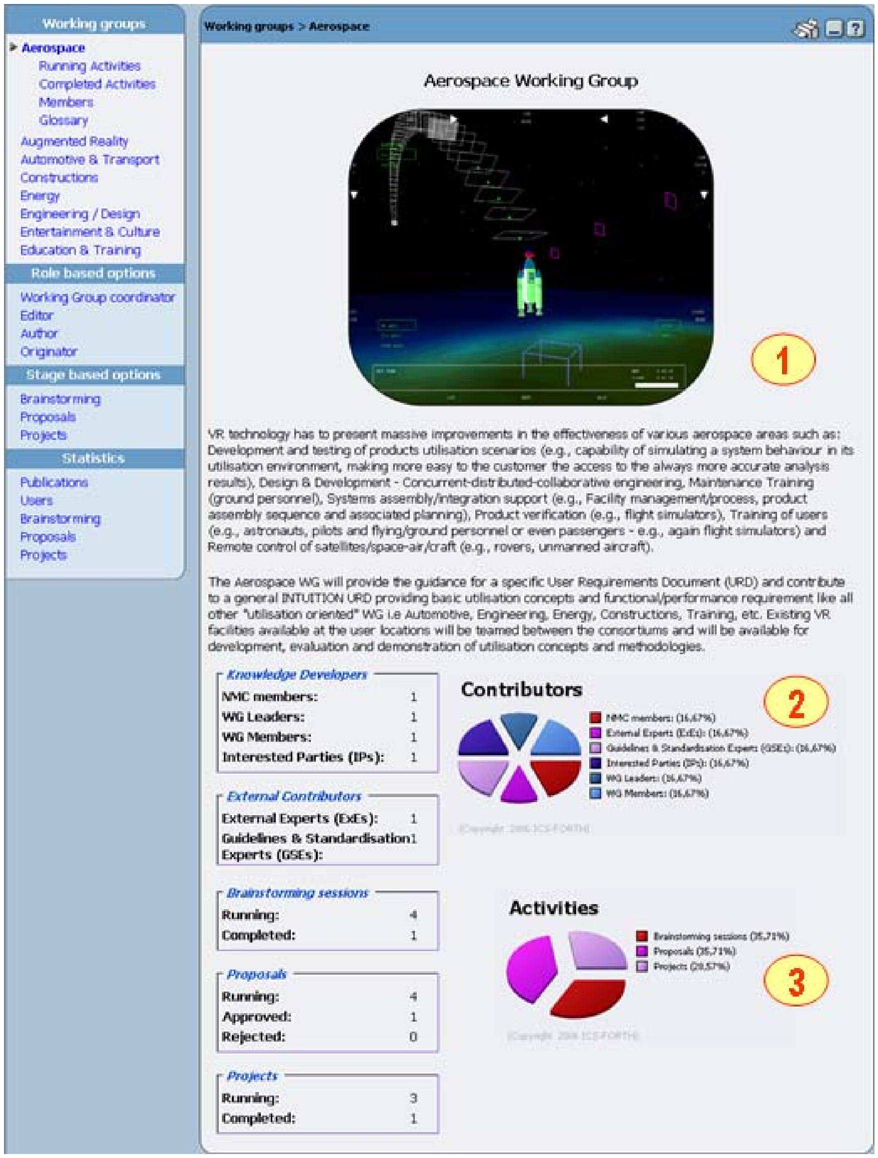


Figure 6:60: WG overview

6.2.5.2.2 Running activities

This option displays all the running activities of a WG according to the three main steps of the CDGS process (chapter 4), providing entrance to the areas where the actual work is carried out. Activities are presented as links for their participants and in non interactive form for all other users. Additionally, for each participant a visual clue is provided to represent the activities with pending user tasks, as opposed to the ones where all the tasks have been carried out, as shown in Figure 6:61.

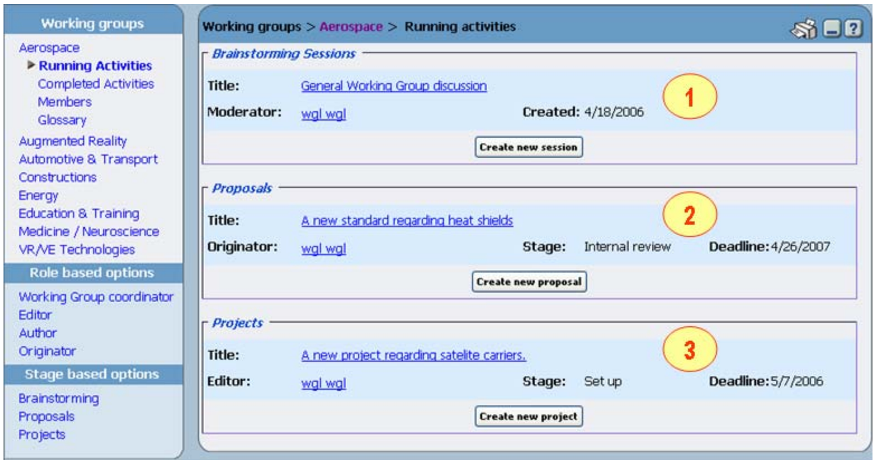


Figure 6:61: The running activities of a WG

The main sections are:

1. **Brainstorming sessions:** These are organized discussions of WG participants aiming at identifying the gaps or needs for standardization within a WG, as described in chapter 4. For each brainstorming session, information about its title, moderator and creation date are displayed.
2. **Proposals:** These provide the available functionality in terms of functions and tools needed by a number of WG participants in order to cooperatively author a proposal, as described in chapter 4. For each proposal, information about it title, originator, current stage and deadline are provided.
3. **Projects:** These provide the available functionality in term of functions and tools needed by a number of WG participants in order to create a CDGS report, as described in chapter 4. For each project, information about its title, editor, current stage and deadline are provided.

6.2.5.2.3 Completed activities

This option displays the completed activities of each WG, according to the three main steps of the CDGS process (chapter 4) (see Figure 6:62).

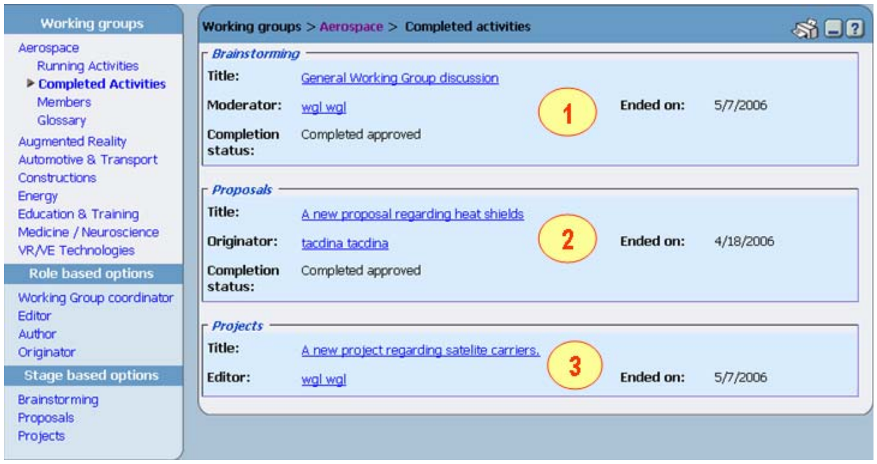


Figure 6:62: The WG completed activities interface

Three main sections are identified, representing:

1. **Brainstorming sessions:** For each completed brainstorming session, information about its title, moderator, status and completion date are displayed.
2. **Proposals:** For each proposal, information about it title, originator, date of completion and completion status are provided.
3. **Projects:** For each project, information about its title, editor, the completion date and completion status are provided.

6.2.5.2.4 Members

Through the members' facility an overview of all the users participating in the WG is offered. For each participant, information such as name, email, affiliation, country and role are presented. This component is organized in two variations according to the role of each participant accessing it as shown in Figure 6:63. The WGL acting as moderator of the WG has access to the tabs representing the subscribed users, the pending subscription requests and the unsubscribed users of the WG. On the other hand all the other WG participants have access only to the subscribed users of the WG.

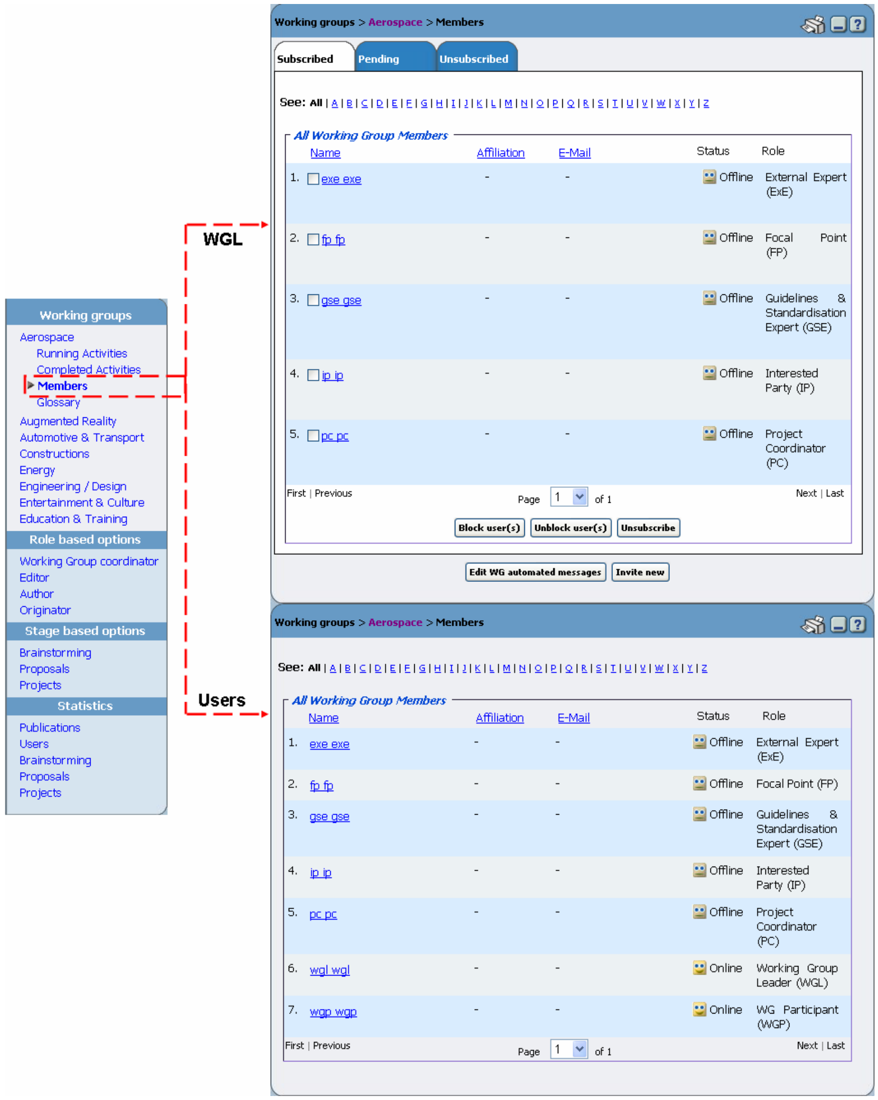


Figure 6:63: The different variations of the Members interface according to the role assignment

The actions that the WG Leader can perform are:

Subscribed users area

1. **Block user:** User can't access the specific WG any longer.
2. **Unblock user:** User regains access to the blocked WG.
3. **View user details:** Access more information about a user.

Pending subscription requests are

1. **Accept subscription:** User gains access to the WG.
2. **Reject subscription:** User access to the WG is denied.
3. **View user details:** Access more information about a user.

Unsubscribed users area

1. **Invite user:** Invite a not subscribed user to this WG.
2. **View user details:** Access more information about a user.

General functions

1. **Edit WG automated messages**: Edit the messages sent to users as a result of WG Leader's actions as shown in Figure 6:64.
2. **Invite new users:** Invite users that are not subscribed in the portal. Invited users are notified via email containing the invitation text and their account information.

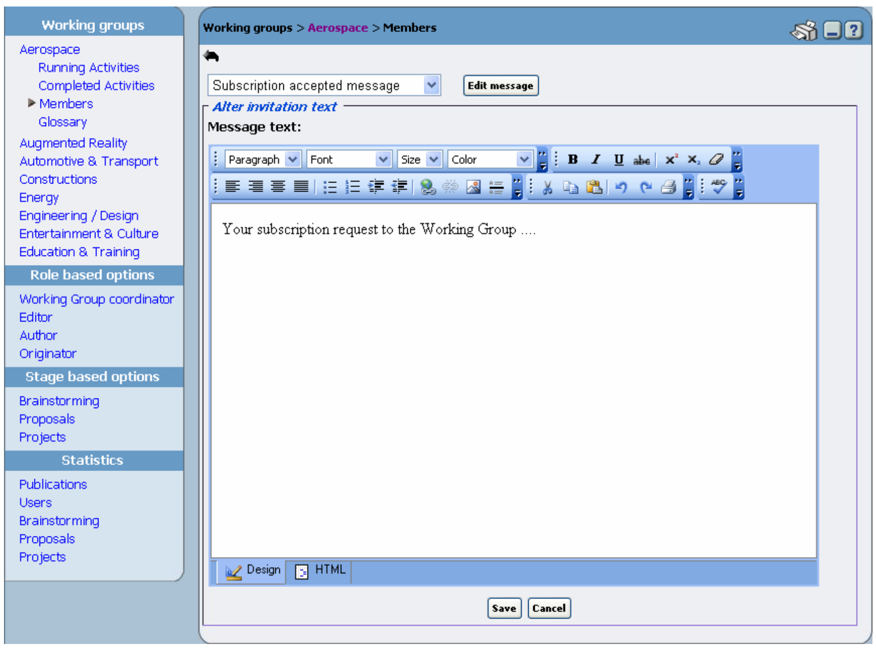


Figure 6:64: Edit Working Group automated messages

6.2.5.2.5 Glossary

The Glossary provides a repository of terms that are relevant to the WG. Participants of the WG can seek terms using the search functionality or by accessing the alphabetical index of terms.

6.2.5.3 Role based options

Role based options provide access to all the pending user tasks according to the role assignment in the context of CDGS activities as shown in Figure 6:65. These options provide a direct entry point to the area of the specific task that must be performed for an activity. This is very important for participants like the WGL participating to a large number of activities within a WG.

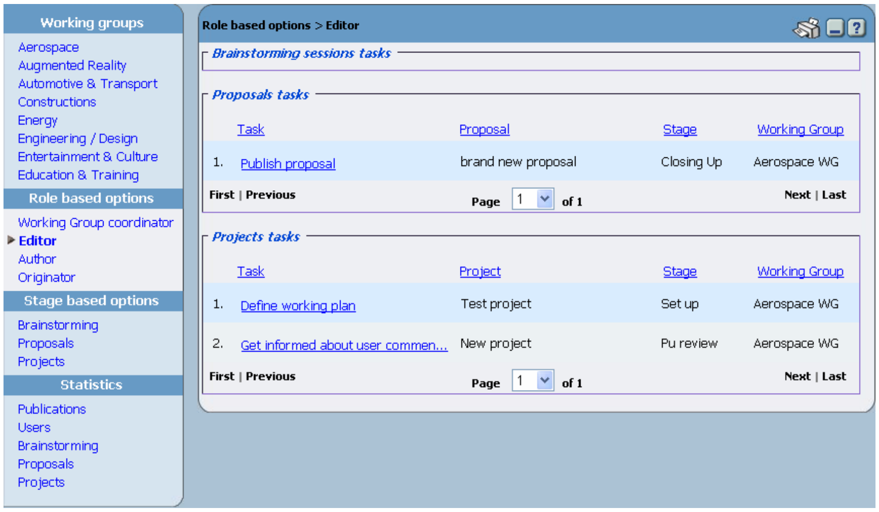


Figure 6:65: The role based options interface for the role of WGL

The alternative selections offered by this area are:

- **Working Group Leader:** Displays all the tasks that that must be performed in the context of activities participating with the role assignment of WGL.
- **Editor:** Displays all the tasks that that must be performed in the context of activities participating with the role assignment of Editor.
- **Author**: Displays all the tasks that that must be performed in the context of activities participating with the role assignment of Author.
- **Originator:** Displays all the tasks that that must be performed in the context of activities participating with the role assignment of Originator.

6.2.5.4 Stage based options

The stage based options provide an alternative to access the activities taking place within WGs. In this option, the activities are categorised in relation with the stages of the CDGS process for all the subscribed WGs.

6.2.5.4.1 Brainstorming sessions

This option displays all the running and completed brainstorming sessions for all the subscribed WGs (see Figure 6:66), thus providing quick access to all the brainstorming sessions, independently from the WG where each session is conducted.

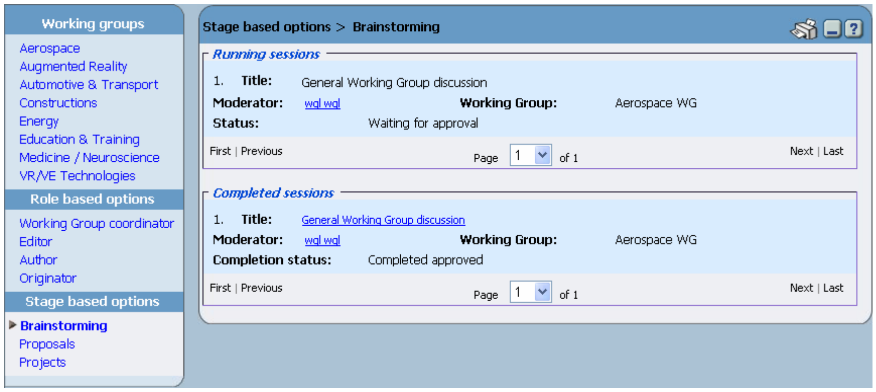


Figure 6:66: The brainstorming stage based option

6.2.5.4.2 Proposals

This option displays all the running and completed proposals for all the subscribed WGs, as shown in Figure 6:67, thus providing quick access to all the proposals independently from the WG where each proposal is elaborated.

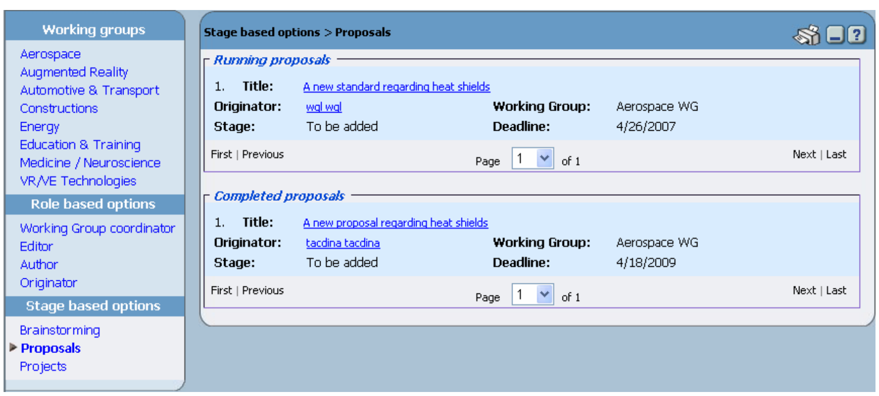


Figure 6:67: The proposals stage based option

6.2.5.4.3 Projects

This option provides to portal participants an overview of all the running and completed projects for all the subscribed WGs, as shown in Figure 6:68, thus enabling users to quickly access all projects in a WG independent way.

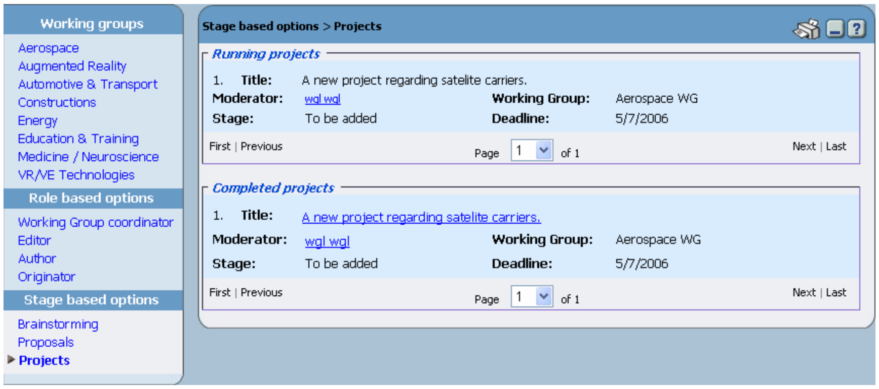


Figure 6:68: The projects stage based option

6.2.5.5 Statistics regarding knowledge development and use

The statistics widget provide to knowledge developers the same information accessed through the web-surfers interface, as described in detail in previous sections.

6.2.5.6 Additional functionality

Through the additional functionality, navigation bar developers gain access to the profiles and subscriptions facilities. These facilities provide to users the same functionality as described in earlier sections in the case of knowledge consumers.

6.2.5.7 News & Notifications

This interface displays all the available news and notifications for each participant .

6.2.5.7.1 News

The news section provides a repository of informative messages accessed by all subscribed users. The messages contained in this area can be either automatically generated by the portal after specific events, such as the creation of a new WG or the initiation of a new proposal, or be inserted manually by portal administrators. The news contained are organised in the following categories:

- Brainstorming
- Proposals
- Projects

- Working Groups
- Knowledge
- General news

The initial news interface displays the latest three items from each of the aforementioned categories, providing access to the full list of news for a category through the selection of the “see all… news” options. The overall process is presented in Figure 6:69.

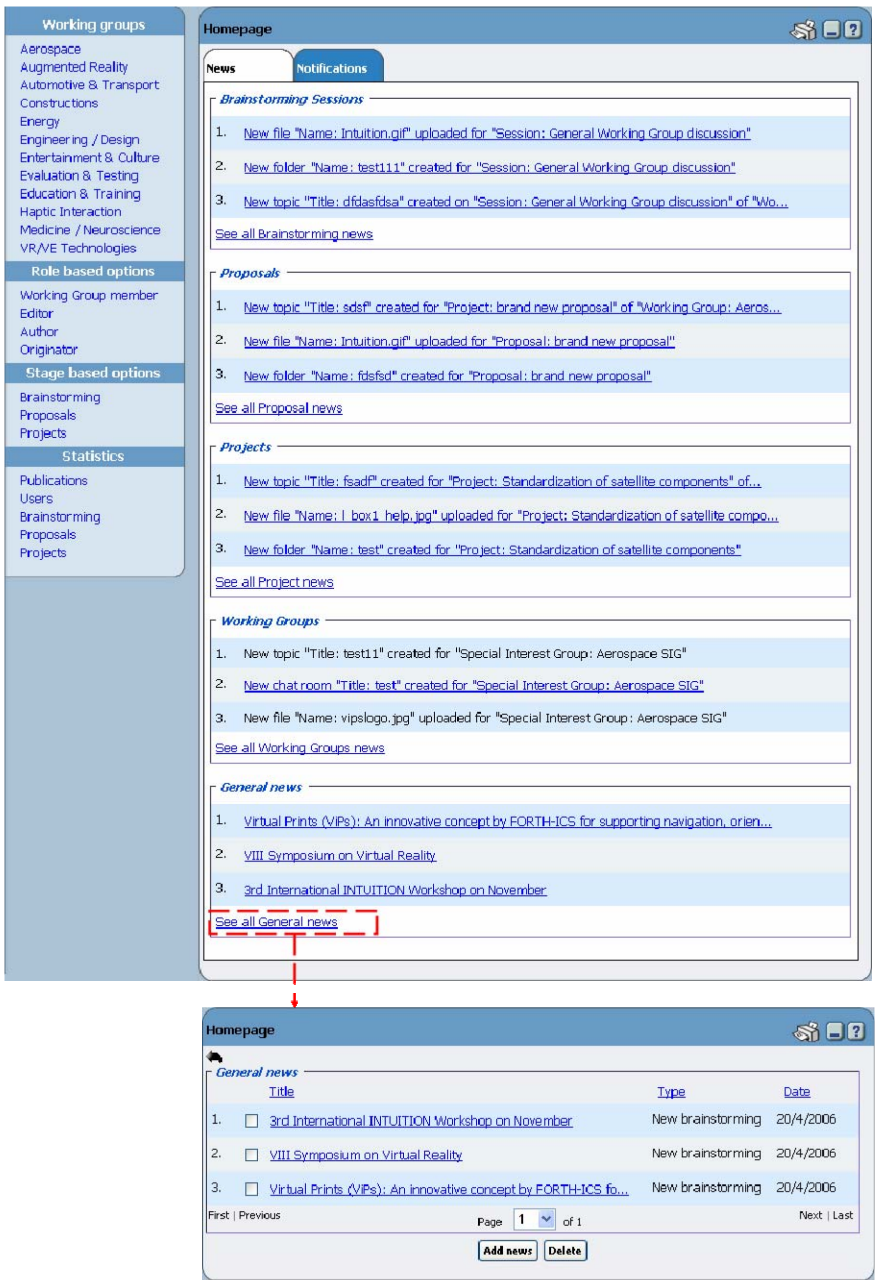


Figure 6:69: Browsing news

Users with the appropriate administrating access rights have the ability to perform the following actions:

- Delete news
- Insert news

6.2.5.7.2 Notifications

The notifications facility plays a very important role in the synchronisation of activities within the portal. The activities carried out through the portal involve potentially a very large number of stakeholders who must cooperate harmonically in order to produce successful results. Additionally, the tasks involved in this process are carried out by a large number of users, who must provide feedback to the process according to specific steps or as a result of specific actions. Towards facilitating collaboration, the notification functionality provides a user based repository of informative messages. These messages are presented as links leading directly to the area where user actions must be performed. Through the main notifications window, the most recent three notifications of each category can be accessed. The available categories of notifications are:

- Brainstorming
- Proposals
- Projects
- Working Groups
- Knowledge

The selection of the “see all notifications link” from each of the aforementioned categories displays the full list of notifications for the specific category. The possible actions that a user can perform through this interface are:

- **Delete notifications:** These notifications are removed from the user’s repository.
- **Clear all notification of the specific category:** All the user notifications for the specific category are removed

The process of browsing notifications is presented in Figure 6:70.

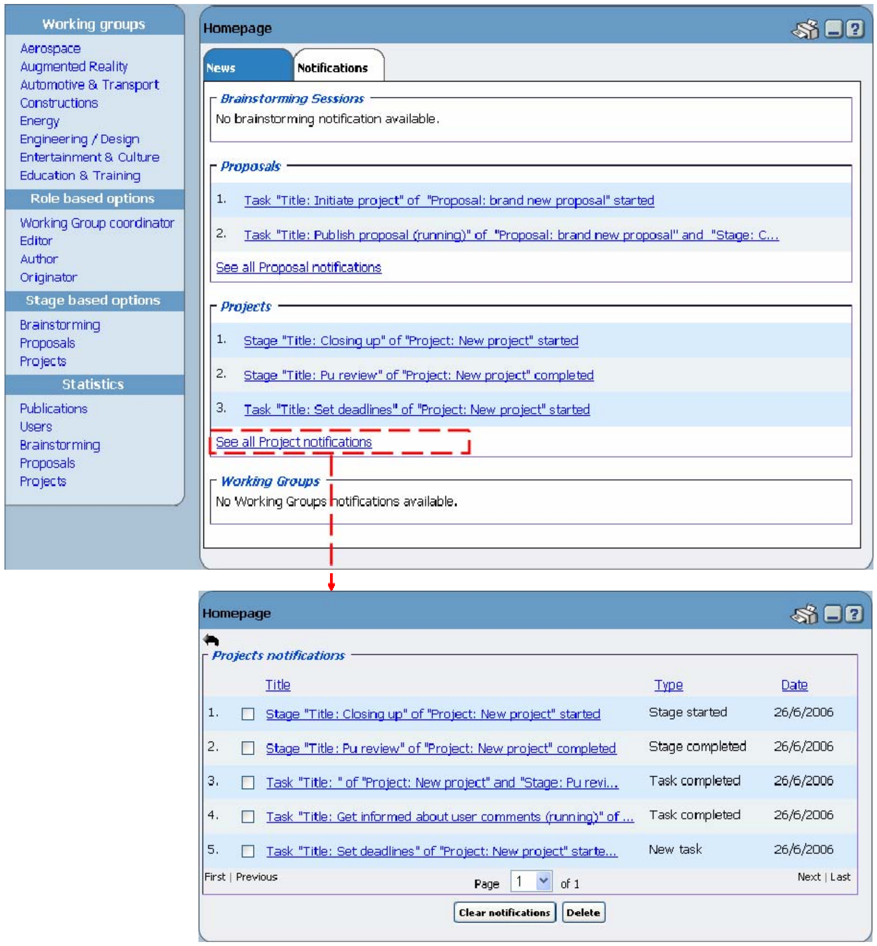


Figure 6:70: Browsing notifications

6.2.5.8 Brainstorming sessions

The purpose of the brainstorming sessions functionality is to provide the appropriate means for conducting web-based discussions about the need for standardization in a specific area of interest. Each brainstorming session is moderated by a person called the brainstorming session moderator, who is responsible for organizing discussions, administrating session documents and finally closing the session. The brainstorming participants use the functionality provided to express opinions, access reference material or propose new material to be circulated in the session.

6.2.5.8.1 Brainstorming session initiation

A new brainstorming session can be initiated with two distinct ways:

- **Directly by the WGL:** the WGL provides the session details and selects the session moderator as shown in Figure 6:71.
- **Indirectly via participant suggestion:** The initiation of a session based on participant suggestion is accomplished in three steps (Figure 6:72):
  1. **Suggest:** A WGM initially provides the title and the abstract of the suggested session.
  2. **Notify:** Proposed sessions appears in the WG running activities as pending for approval.
  3. **Evaluate:** The responsibility of evaluating proposed sessions is assigned to the WG Leader. After the acceptance of a session, the functionality offered can be accessed by all WG Members. On the other hand, the rejection of a session results to its withdrawal.

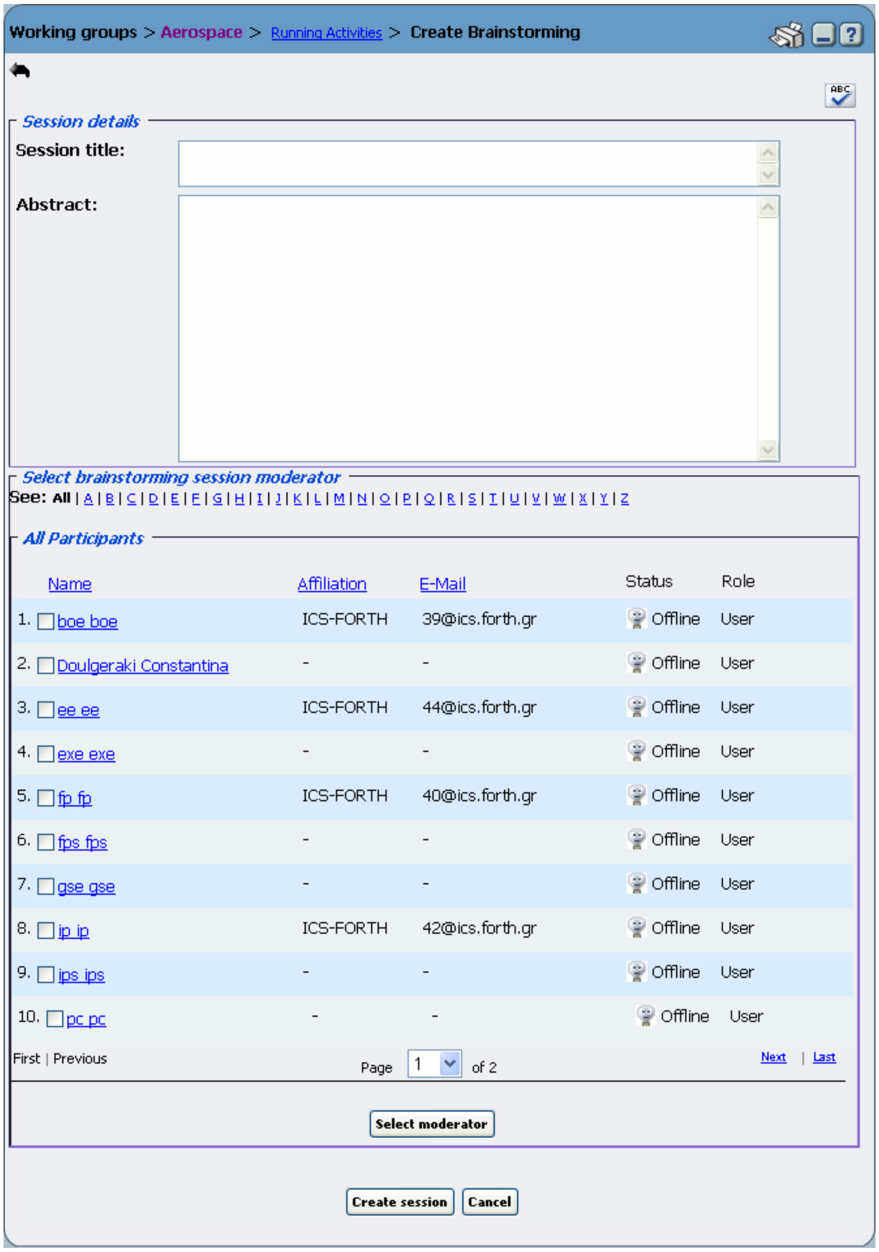


Figure 6:71: Session initiation by the WGL

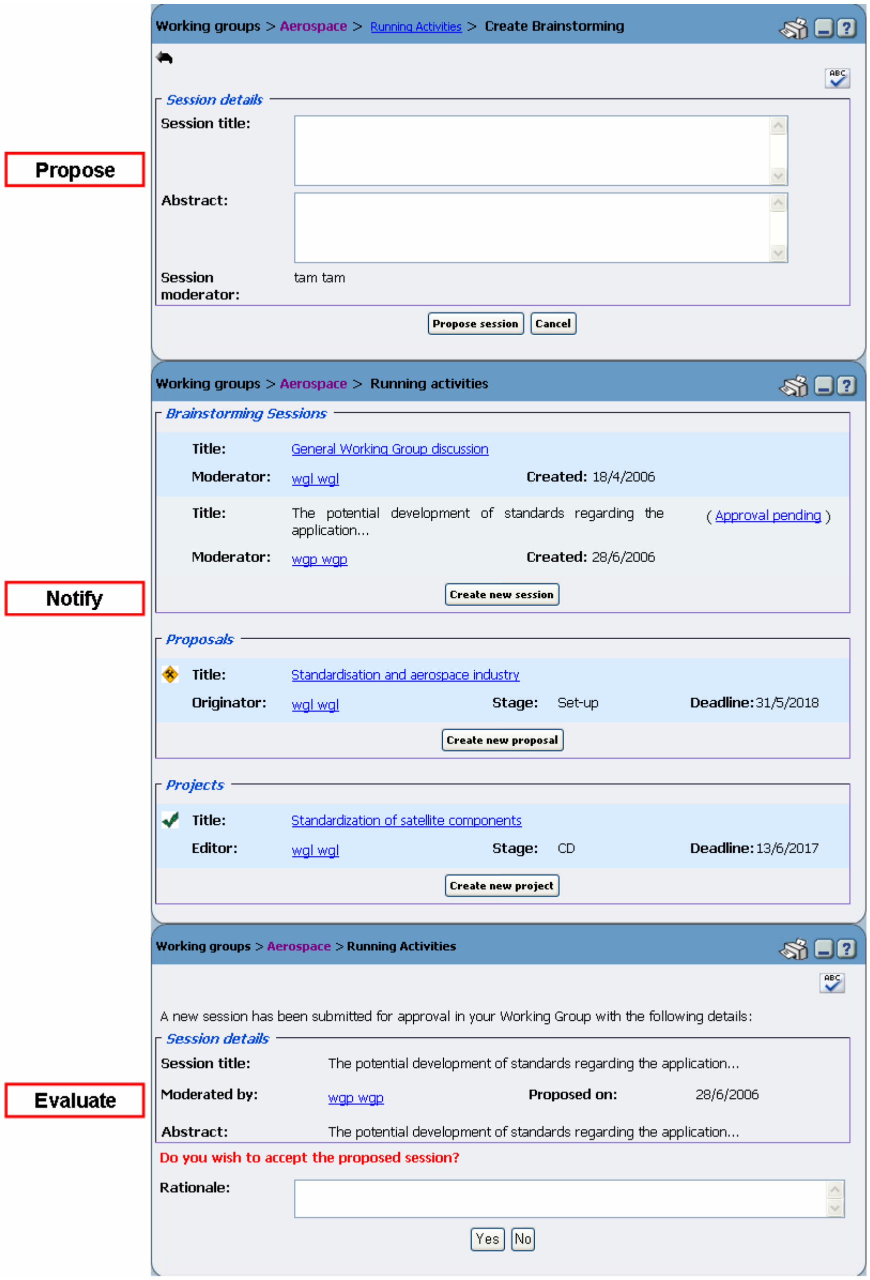


Figure 6:72: Session initiation via participant suggestion

6.2.5.8.2 Brainstorming session functionality

The initial interface of the brainstorming session is presented in Figure 6:73.

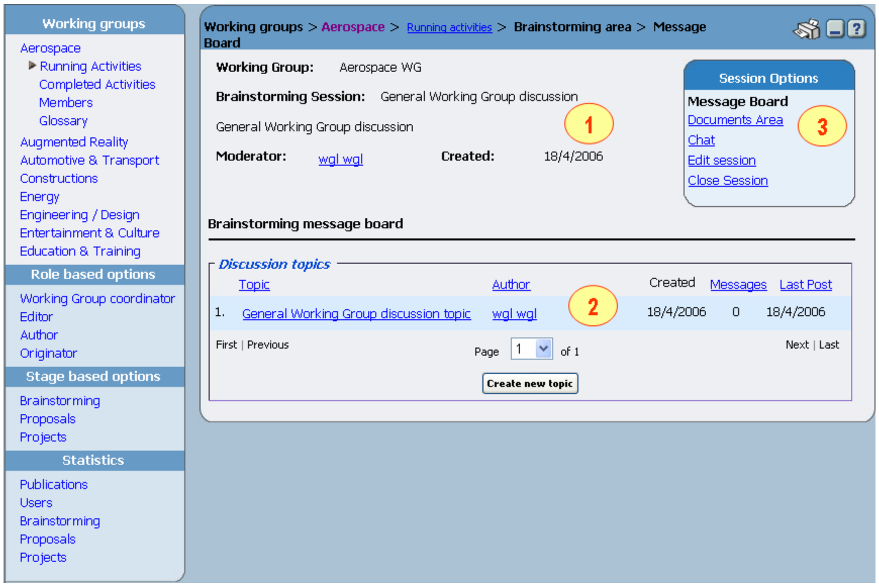


Figure 6:73: The initial interface of a brainstorming session

The main areas of a brainstorming session are:

1. Session details
2. Session options
3. Selected option content and functionality

Each of the aforementioned areas is analysed in depth in the following sections.

Session details

This area constantly appears while participating in a brainstorming sessions and provides information about the session, such as:

- Title
- Abstract
- Moderator
- Creation date

Selected option content and functionality

This region presents the content of each option selected from the Session Options section.

Session options

The brainstorming session interface provides different options regarding the role of each participant. A brainstorming moderator has access to the options shown in Figure 6:74.

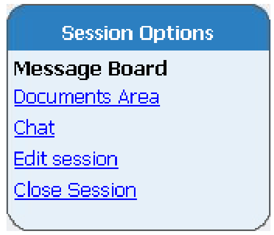


Figure 6:74: The moderator view of session options

On the other hand, a simple participant of a brainstorming session has access to the options shown in Figure 6:75.

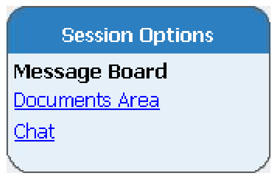


Figure 6:75: The brainstorming participant view of session options

Brainstorming session chat

Using the chat functionality, users of a brainstorming session can participate to real time conversations with other participants currently online, as shown in Figure 6:76. All the discussions taking place in each brainstorming session are recorded and available as reference material to all the participants of the WG after the completion of a session.

Figure 6:76: Brainstorming session chat

Brainstorming session message board

The greatest amount of discussions taking place in a brainstorming session is carried out through the message board functionality. The discussions in the message board are organized in a number of discussion topics, as shown in Figure 6:77 . Each topic may represent an area of interest. Each participant of a brainstorming session is free to create new discussion topics. This policy was followed in order to provide the greatest possible flexibility of discussions. Upon completion of a session, the topics created and the messages submitted are archived and available for reference to all WG Members.

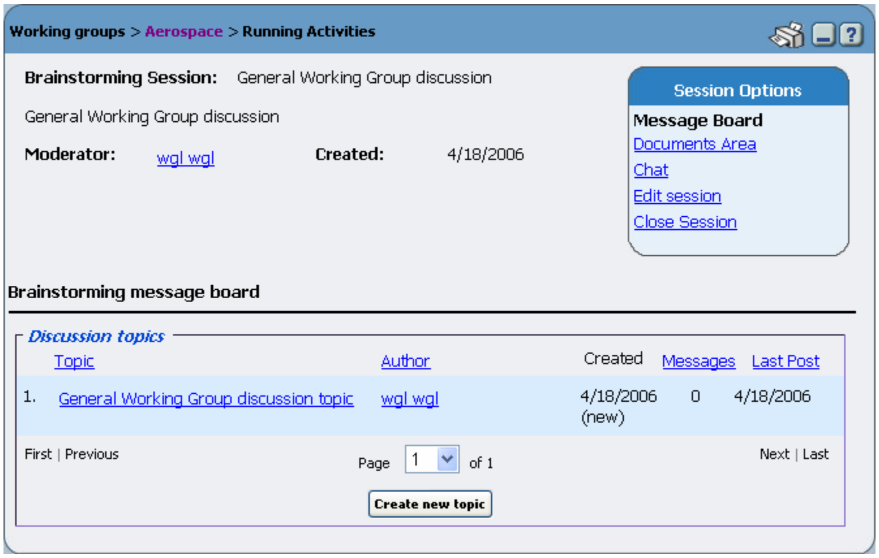


Figure 6:77: Brainstorming session message board

Brainstorming session documents area

Except from organized discussions, a brainstorming session should provide the means to its participants to exchange reference material. This task is carried out with the help of the documents area functionality shown in Figure 6:78. The Documents area provides a file-system like interface where users can upload and download files. In the case of a brainstorming session, the session moderator acts as administrator of the documents area. The related tasks include the administration of the file system and the evaluation of documents uploaded by brainstorming participants. These documents are published to documents area only upon approval by the session moderator. On the other hand, session participants can download the reference material uploaded by other users. With the completion of a session, all the material uploaded to the session documents area is archived and available to all WG Members.

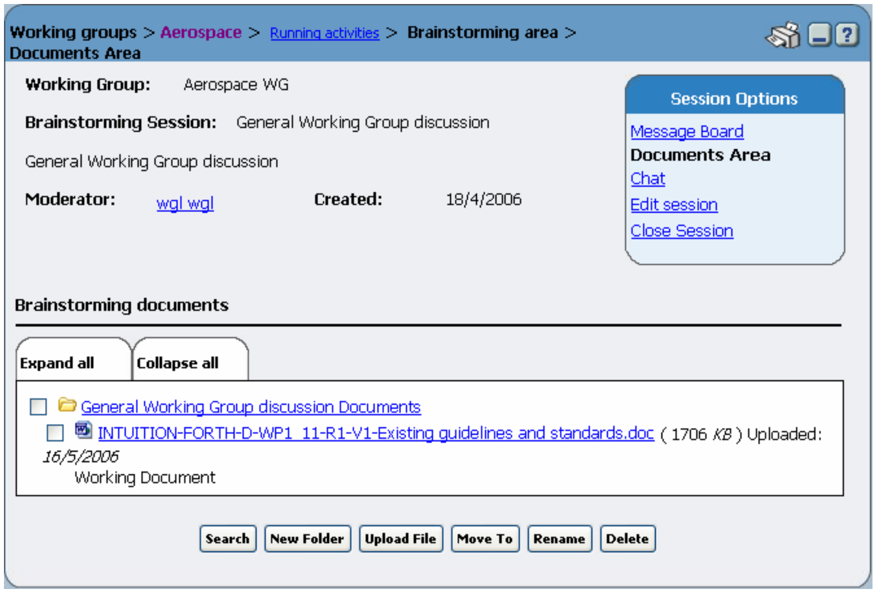


Figure 6:78: Brainstorming session documents area

Edit session details

The moderator of a brainstorming session has also the option to edit session details, as shown in Figure 6:79. The editable details are the session title and abstract.

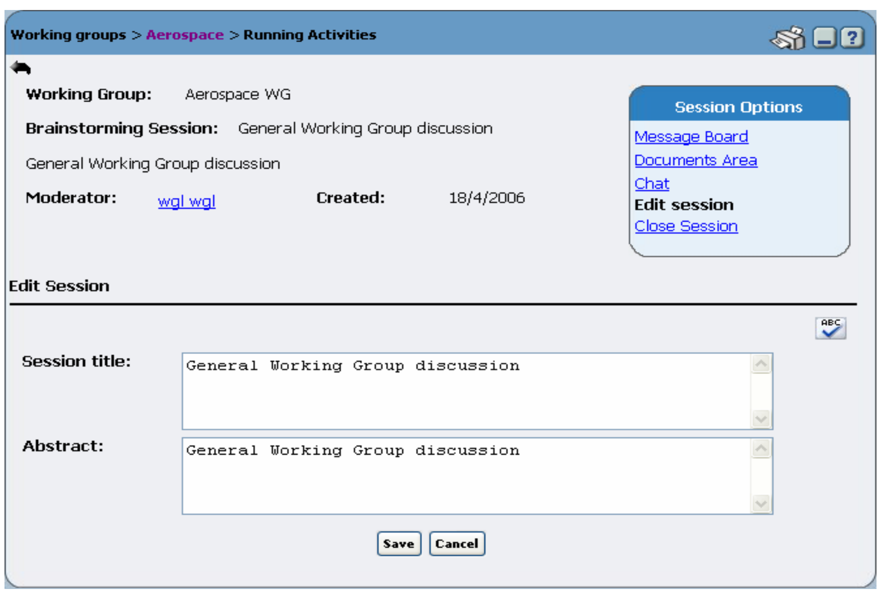


Figure 6:79: The edit session interface

Close session

When the moderator of a session decides that the purpose of the brainstorming session is fulfilled, the brainstorming can be closed using the Close Session option, as shown in

Figure 6:80. By closing a session, all the discussions that took place are archived and the discussion topics are closed, and the brainstorming session is no longer available as a running activity of the WG.

Figure 6:80: The close session interface

Closed Sessions

A closed brainstorming session plays a very important role for achieving the goals of a WG. Through these sessions, WG Members can access all the discussions that leaded to specific results in the context of the WG. Therefore, a closed session is a living part of the activities within the WG, and can provide valuable information about the history of these activities. In the case of closed sessions all available functionality is persistent in a non interactive read-only form.

6.2.5.9 Proposals

Once a new concept for a CDGS Project has been formed through a brainstorming session, the proposal preparation phase can be initiated. This phase aims at creating a proposal document that entails all information needed in order to justify the need to proceed with the Project according to the CDGS process (Chapter 4). More specifically, a proposal may contain information about the scope, objectives and applicability of the project outcome, the potential impact etc. The proposal preparation is presented by the tool in the form of the proposals module.

6.2.5.9.1 Proposal roles

Each contributor of a proposal is assigned with a specific role. The access rights to the proposal resources and the tasks that must be performed vary according to the role assignment of each contributor. Six different roles may be assigned to contributors of a proposal:

(a) **Originator:** This is the person that proposed the preparation of the proposal or the WGL.

(b) **WGL:** Person responsible to co-ordinate technically all proposals within a WG.

(c) **NMC Leader:** Person responsible for the operational work issues and general decision making with regards to the CDGS Process.

(d) **FP:** Person acting as contact persons to the WG's Interest Parties (industry representatives).

(e) **IPs:** Person(s) who represent the target market for CDGS Reports.

(f) **Authors:** Person(s) participating to the drafting of the proposal.

6.2.5.9.2 Proposal initiation

A new proposal can be initiated in two different ways:

- **Directly by the WGL:** WG Leader acting as coordinator of the WG can initiate new proposals providing the proposal title, abstract and submission deadline, as shown in Figure 6:81.
- **Indirectly through a participant's suggestion:** This way of initiation involves three steps (Figure 6:82)
  - **Suggest:** All the participants of a WG can make suggestions about new work proposals.
  - **Notify:** The suggested proposals appear as pending for approval in the WG running activities.
  - **Evaluate:** Suggested proposals are evaluated by the WG Leader. Only upon acceptance by the WG Leader a suggested proposal is initiated.

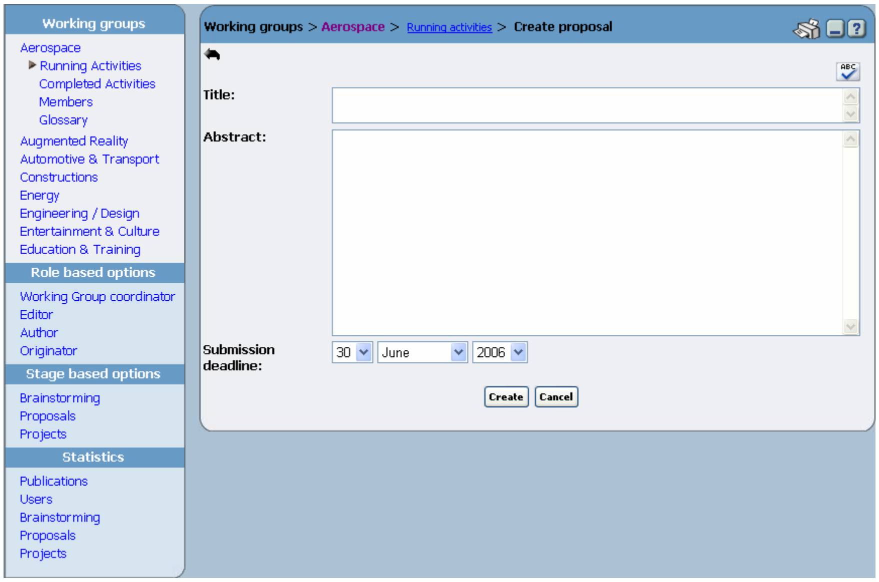


Figure 6:81: Initiation of a proposal by the WG Leader

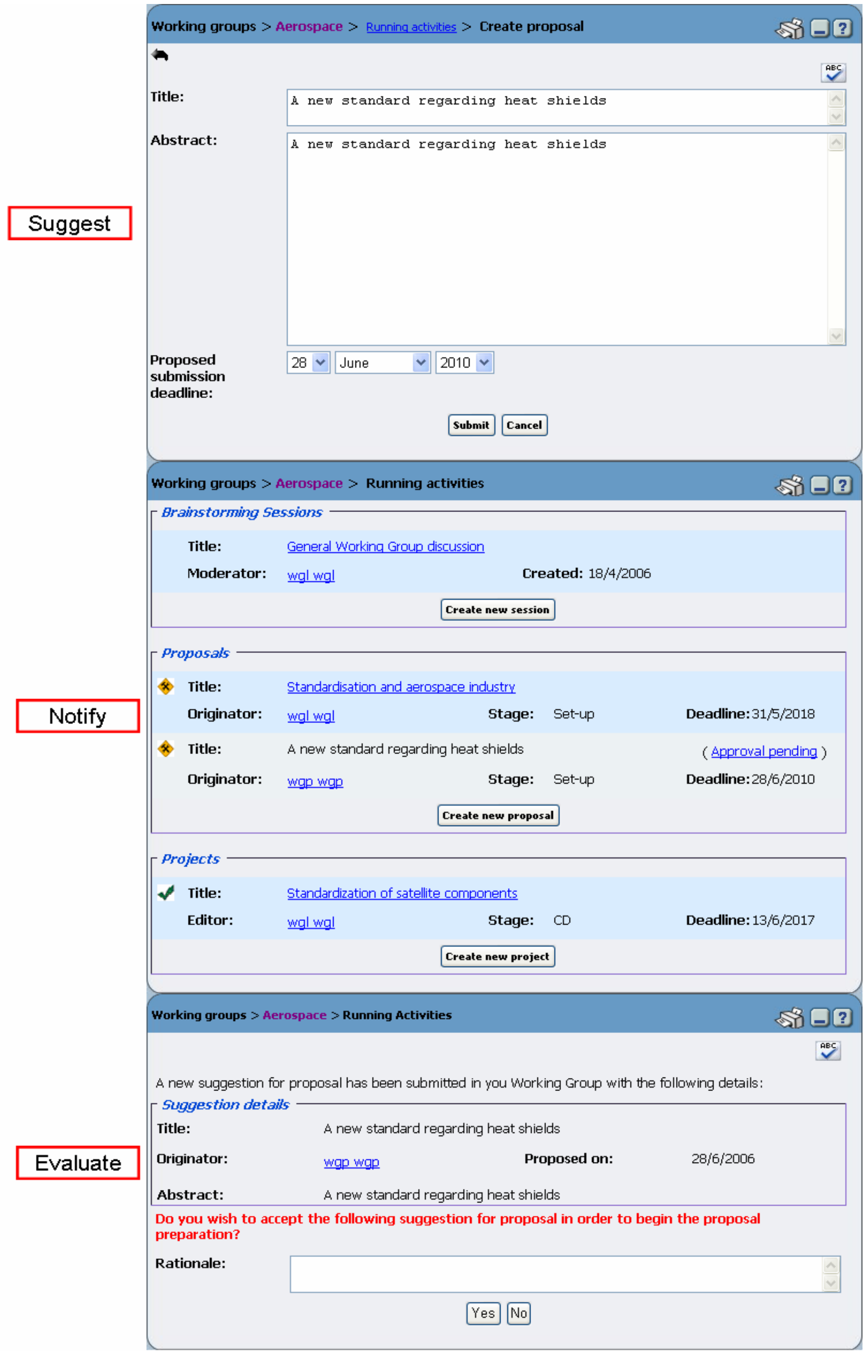


Figure 6:82: Initiation of proposal via participant suggestion

6.2.5.9.3 Proposals functionality

The initial interface of a proposal is displayed in Figure 6:83.

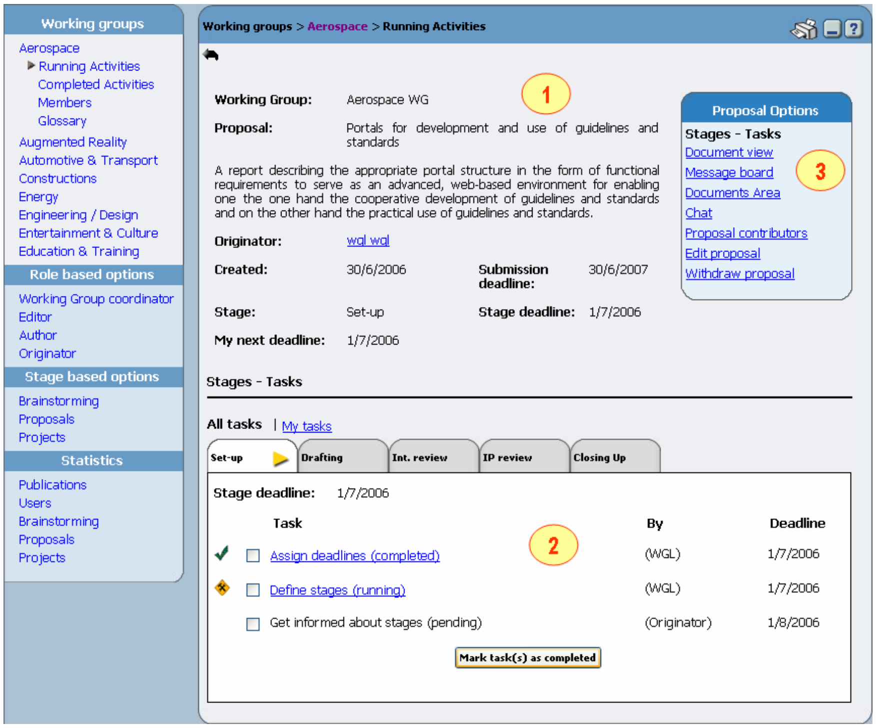


Figure 6:83: The initial interface of a proposal

Three distinct can be identified, and namely:

1. **Proposal details**
2. **Proposal selected option functionality**
3. **Proposal options**

Each of the aforementioned areas is presented in depth in the following sections.

Proposal details

This area constantly appears while working in a proposal, and provides information such as:

- Title
- Abstract
- Originator
- Creation date
- Submission deadline
- Current stage
- Stage deadline

- User’s next deadline (different for each user, represents the deadline of the current task that a user must perform)

Proposal selected option functionality

This area presents the content of each proposal option selected from the option section.

Proposal options

This area constantly appears while working in a proposal and provides the options available to proposal contributors. There are two different setups of this area according to the role of the participant. The options available to the proposal Originator are presented in Figure 6:84.

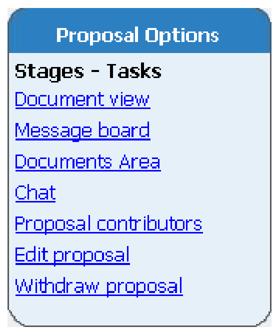


Figure 6:84: The options provided to proposal originator

On the other hand, the options provided to the rest of the proposal contributors are shown in Figure 6:85.

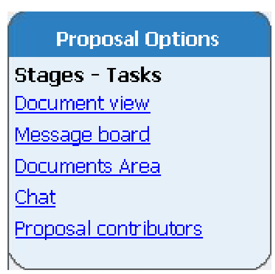


Figure 6:85: The options provided to all proposal contributors that are not originators

Stages – Tasks

This section displays the stages and tasks needed to complete the preparation of a proposal, as shown in Figure 6:86. In this interface the stages to be carried out are displayed as tabs, each of them containing the tasks foreseen for each stage. For each task the following information are presented:

- The task name.
- The user role responsible for completing the task.
- The deadline assigned to each task.

Additionally, in each tab, the deadline of the current stage is displayed. According to the role assignment of each contributor, checkboxes appear next to the tasks that can be completed by the contributor currently browsing the interface.

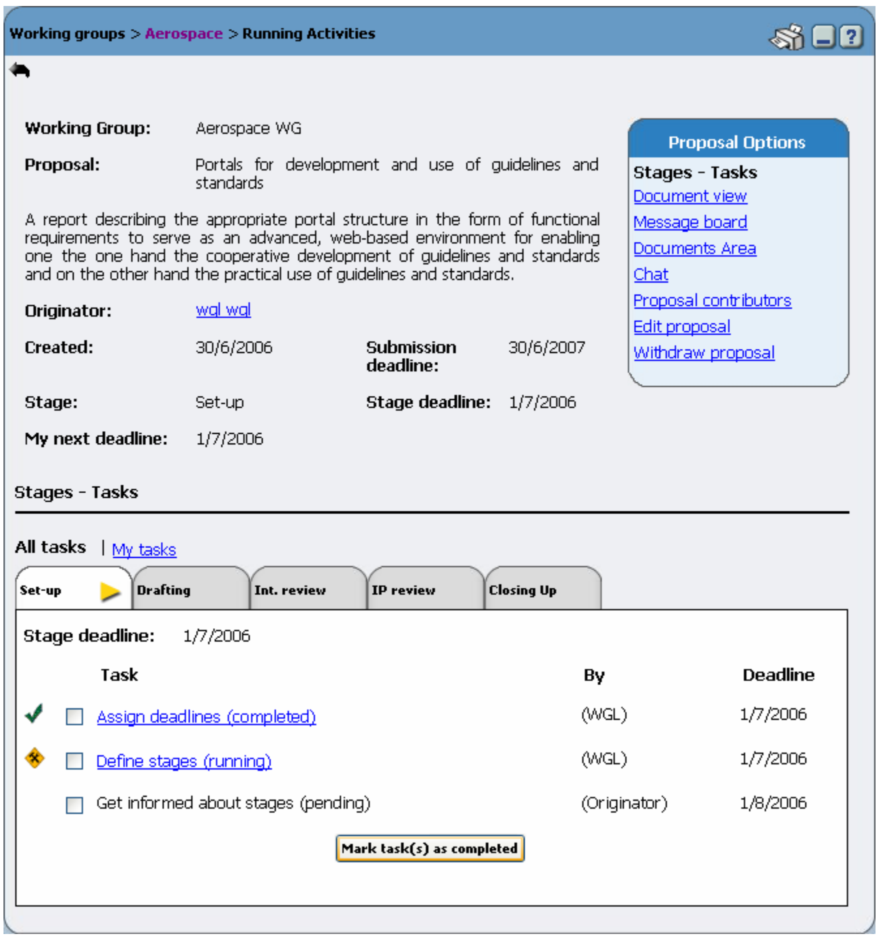


Figure 6:86: The Proposal Stages-Tasks interface

Document view

Document view provides the document equivalent of the proposal under development throughout all the stages of the proposal development life cycle, as shown in Figure 6:87. Using this option, each contributor can gain access to the full version of the proposal document and not only to the areas (chapters) assigned to each contributor. This interface displays initially the table of contents of the report. Each of the report chapters is displayed as a link. The selection of each of the aforementioned links navigates to the actual content of the chapter. At the end of each chapter's content, an additional link is provides for moving back to the table of contents.

Figure 6:87: The proposal document view interface

Message Board

The proposal message board is the area where the major part of interaction and communication among proposal contributors takes place. With the help of this facility, contributors can communicate and discuss issues related to the various stages of the proposal. The discussions in the message board facility are organized in a number of discussion topics where proposal participants can post messages expressing their opinion on issues related to the proposal preparation.

Documents area

The proposal document area acts as a common repository of documents for proposal contributors. With the help of this facility, the Originator can upload useful reference material to be considered by proposal contributors. Additionally, contributors can propose documents to be circulated in the proposal after approval by the Originator.

Chat

The proposal chat is the place where proposal contributors online at a specific time can participate to real time discussions concerning the proposal. For example, the authors of a proposal chapter can discuss the way that the chapter should be structured or the way that the comments made during a review should be incorporated in the chapter text, etc.

Proposal contributors

The proposal contributor facility shown in Figure 6:88 provides an area where the originator of a proposal can administer the contributors. The administration tasks that can be performed in this area are the invitation of new contributors and the removal of inactive ones. Additionally, from this area all proposal contributors can access a list of all the contributors participating in the proposal preparation, along with the role assignments of each contributor and its personal information.

Figure 6:88: The "proposal contributors" interface

Edit proposal

The originator of the proposal has the option at each stage of the proposal life cycle to edit the proposal details accessed by proposal contributors (see Figure 6:89). The editable information of a proposal is the title and abstract.

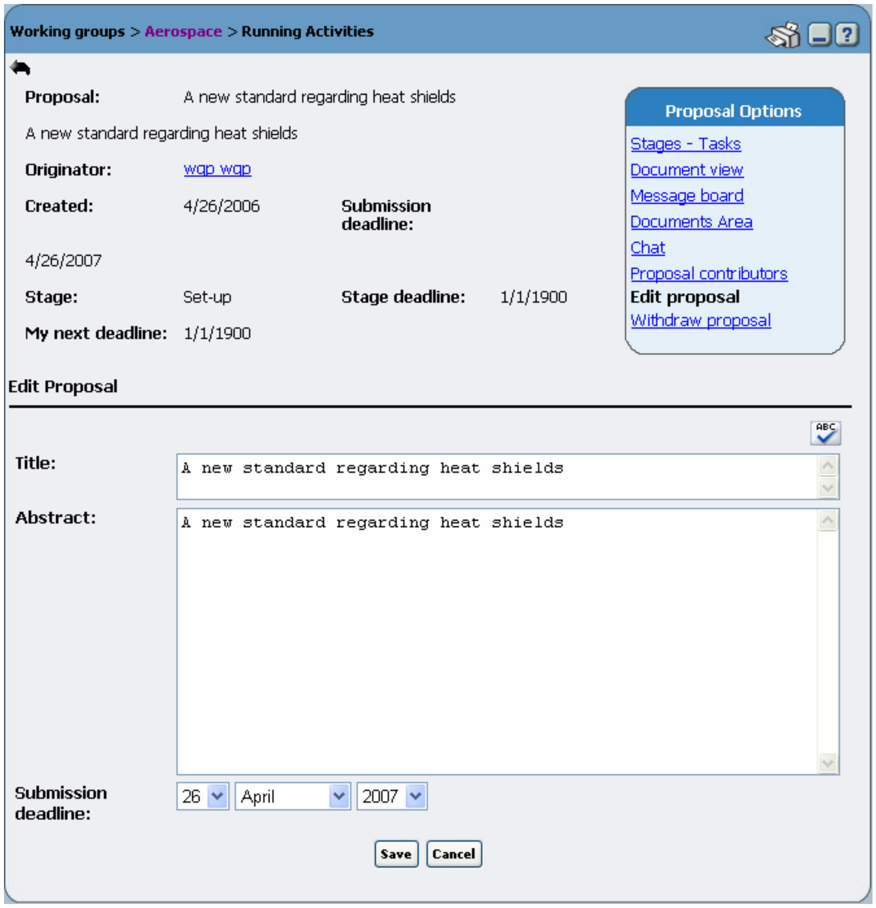


Figure 6:89: The edit proposal details interface

Withdraw proposal

The Originator can choose to withdraw a proposal in each phase of the proposal life cycle, as shown in Figure 6:90. In this case, the proposal appears in the completed activities as withdrawn. Withdrawal usually occurs when the contributors of the proposal can not provide the required information to support the proposal and the Originator decides that the process cannot be completed successfully.

Figure 6:90: The withdraw proposal interface

6.2.5.9.4 Running a proposal

This section describes the stages and tasks involved in the context of proposal preparation. More specifically the proposal preparation involves the following stages:

- Set-up
- Drafting
- Internal review
- IP review
- Closing Up

The initial task involved in each of the aforementioned stages is the assignment of deadlines to the tasks contained in each stage, thus generating the stage time table. This timetable will be subsequently used to inform all proposal contributors about the time limit set to their activities. An example of this process is presented in Figure 6:91. The following sections present an in depth description of the tasks involved in each stage of a proposal.

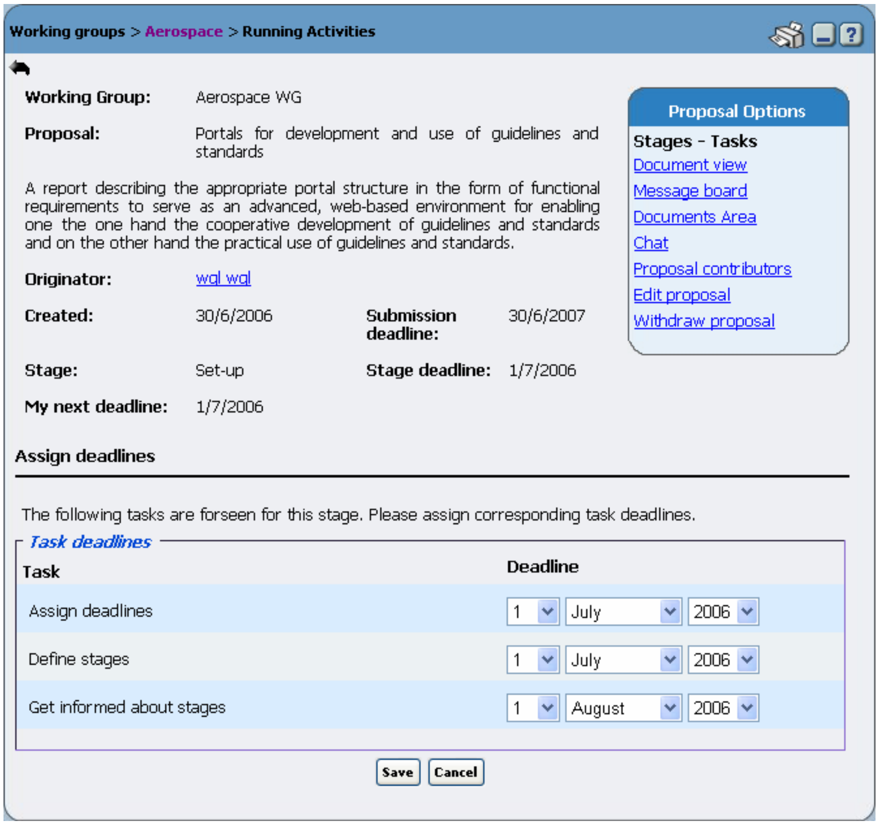


Figure 6:91: An example of deadlines assignment for the Set-up stage

Set-up

The initial stage of the proposal preparation is set-up. To complete the set-up stage, three steps need to be carried out (Figure 6:92), and namely:

- Assign deadlines
- Define stages
- Obtain information about stages

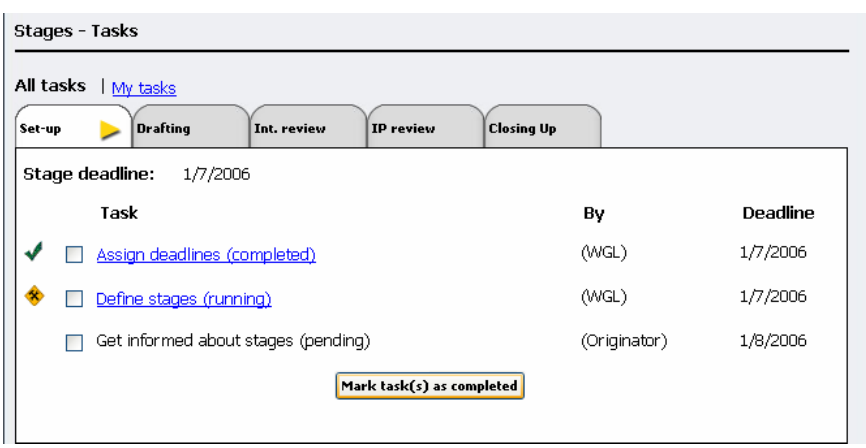


Figure 6:92: The tasks foreseen for the Set-up stage

Assign deadlines

The objective of this task is to assign deadlines to the tasks contained in the Set-up stage, thus generating the stage time table.

Define stages

The purpose of this task is to define the proposal outcome and assign deadline to the corresponding stages, as shown in Figure 6:93. These stages vary according to the outcome selected. The possible outcomes of a proposal can be one of the following:

- **Proposal for new project:** All the stages of the proposal must be completed
- **Publicly available specification:** IP review skipped
- **Technical report:** Internal review and IP review skipped

This task provides feedback to proposal contributors in order for them to have a clear view regarding the type of document to be developed and the stages that must be carried out. Skipped stages are marked as such in the proposal stages tabs.

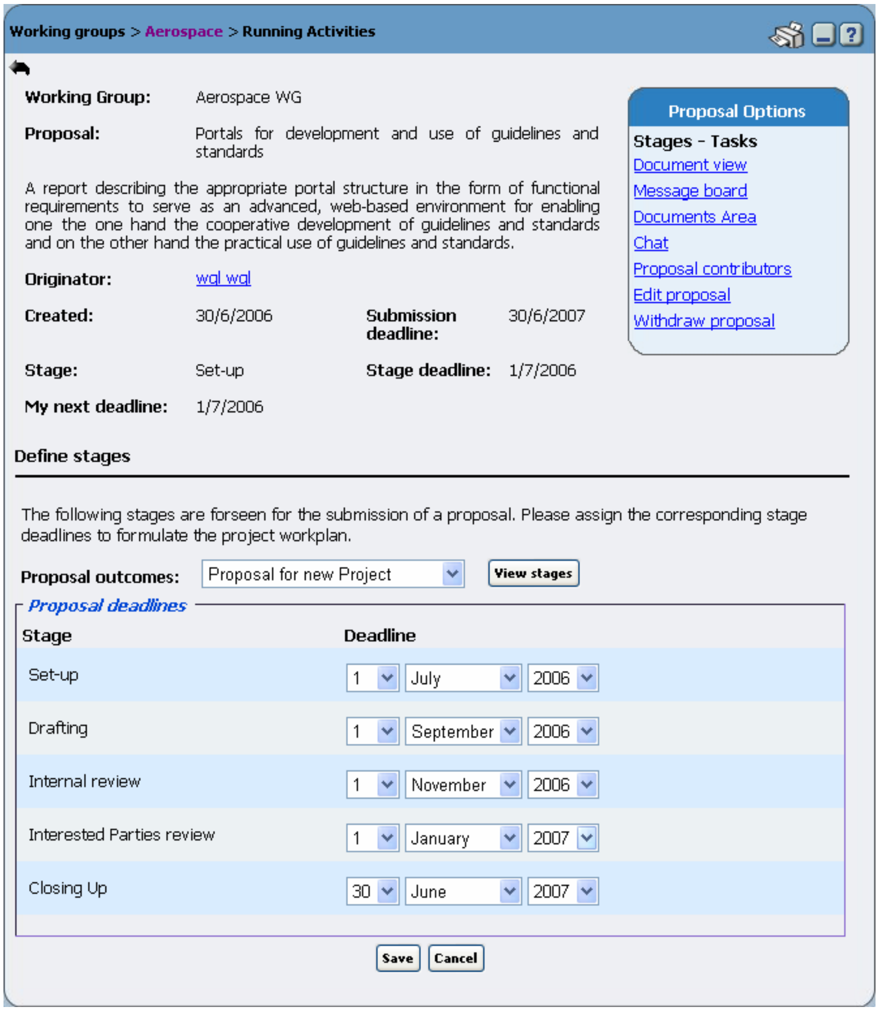


Figure 6:93: Defining the stages to be carried out

Obtain information about stages

The objective of this task is to inform the Originator about the selected proposal outcome and deadlines assigned to stages, as shown in Figure 6:94. Originator and proposal contributors must respect the deadlines set by WGL in order to successfully and timely complete the proposal preparation.

Figure 6:94: Informing originator about the selected proposal outcome and assigned deadlines

Drafting

The next stage of the proposal preparation is Drafting. To complete this stage, the following tasks shown must be carried out (see Figure 6:95):

- Assign deadlines
- Invite Contributors
- Propose chapters
- Assign chapters to authors
- Authoring draft proposal

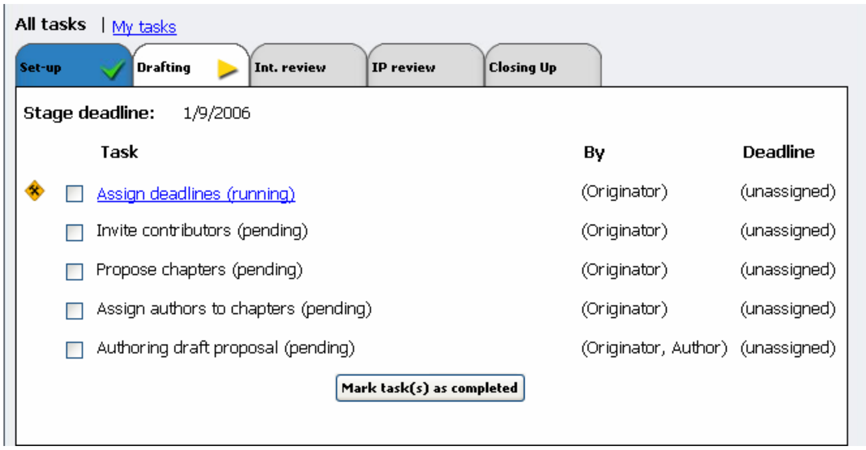


Figure 6:95: The drafting stage of a proposal

Assign deadlines

The objective of this task is to assign deadlines to the tasks contained in the Drafting stage, thus generating the stage time table.

Invite Contributors

Each proposal is assigned an initial list of contributors during creation. These contributors are the Originator, the WGL and the NMC Leader. The aim of the Invite Contributors task is to form the final contributors list of the proposal by enabling the originator to invite additional contributors. This task requires from the Originator to select the members to be invited from the available WGMs and provide their role assignment, as shown in Figure 6:96. After completion of this process, notifications are submitted (via e-mail and through the portal) to the invited members. These members are added to the proposal contributors list only after acceptance of their invitation. These invitations are accessed through the notifications functionality.

Figure 6:96: Inviting proposal contributors

Propose chapters

During this task the proposal table of contents is generated. The Originator of the proposal proposes the chapters to be included in the proposal. The functionality offered to carry out this task supports the creation of an n-level hierarchy of chapters using the following functions (see Figure 6:97):

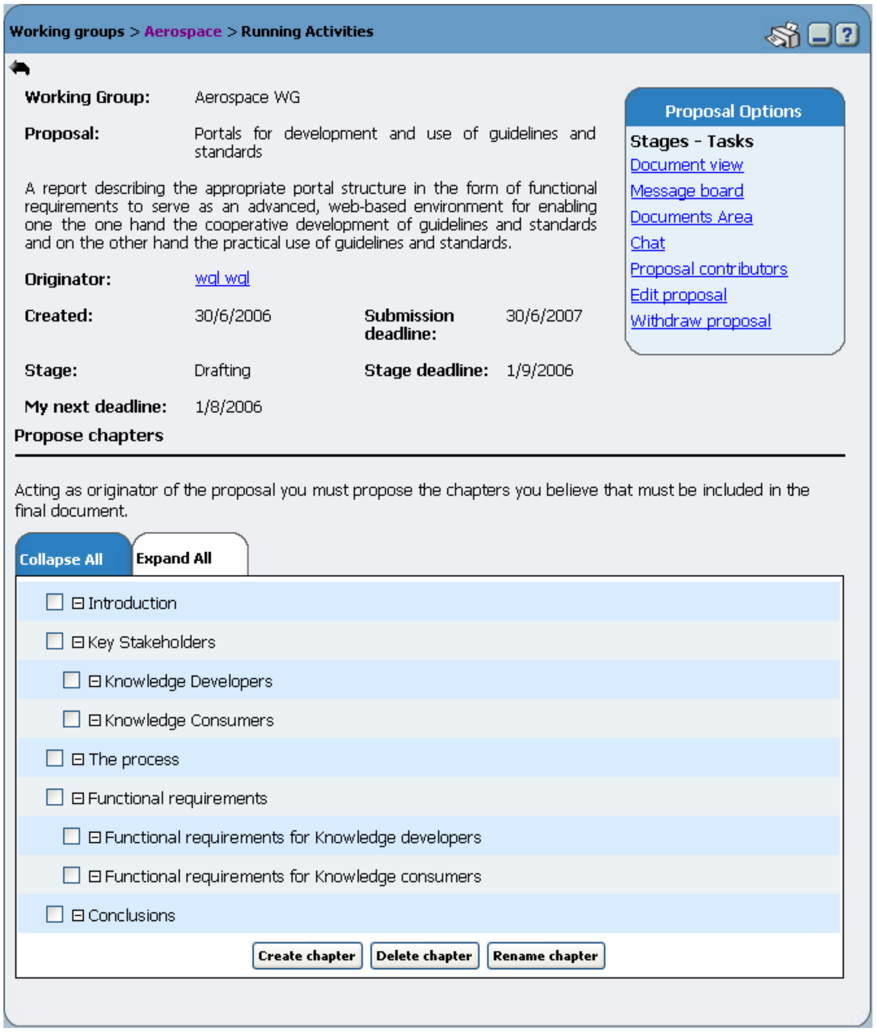


Figure 6:97: Creating the chapter hierarchy of the proposal

- **Create chapter**: The Originator must specify the parent chapter in the case of a subchapter or directly select this function in the case of a root chapter. Additionally, the provision of a title, editor comments, start and due date are required. This information is important in order for chapter authors to have a clear picture about the chapter topic and the time constraints set to their drafting activities.
- **Delete chapter(s):** The delete function is simply accomplished by selecting the chapters to be deleted and pressing the delete button.
- **Rename chapter(s):** The rename chapter function is simply accomplished by selecting the item to be renamed and pressing the rename button. A new name for each item to be renamed is requried.

The overall functionality available for administrating chapters is shown in Figure 6:98.

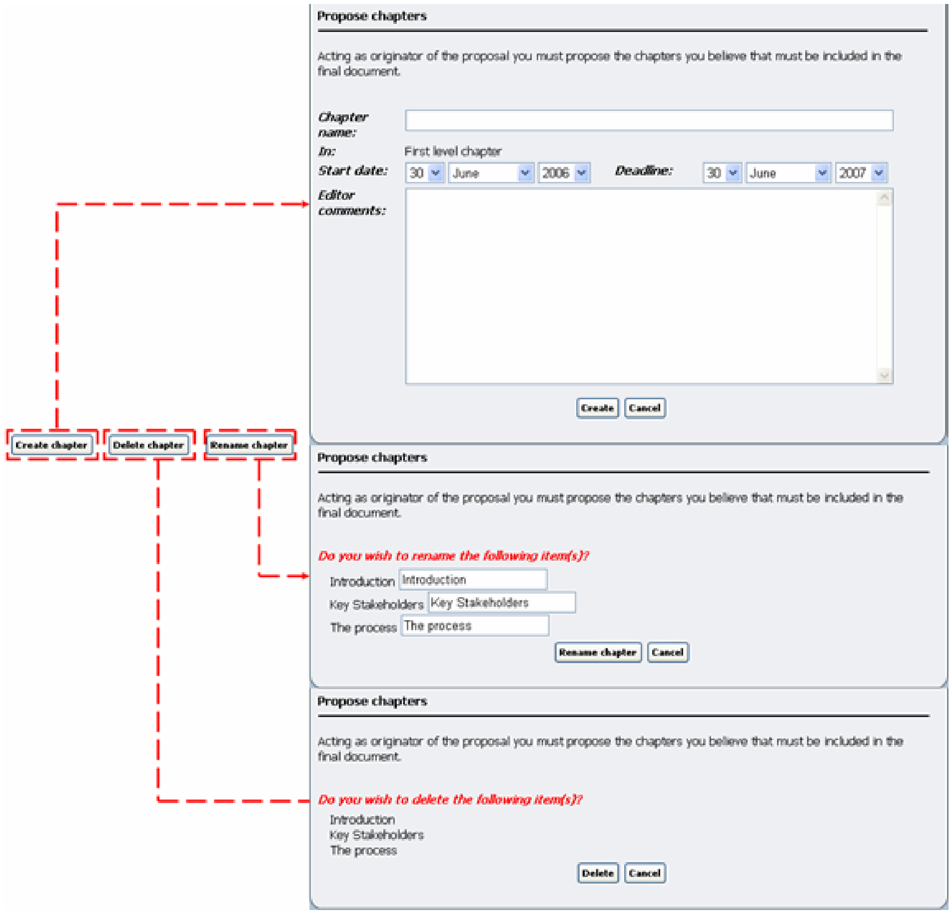


Figure 6:98: Chapters functionality

Assign chapters to authors

The objective of this task is the assignment of individual chapters to proposal contributors (authors). This task requires the selection of the chapters to be assigned and the subsequent selection of the chapter authors, as shown in Figure 6:99. Each chapter can be assigned to more that one authors and each author can participate to the drafting of more than one chapter.

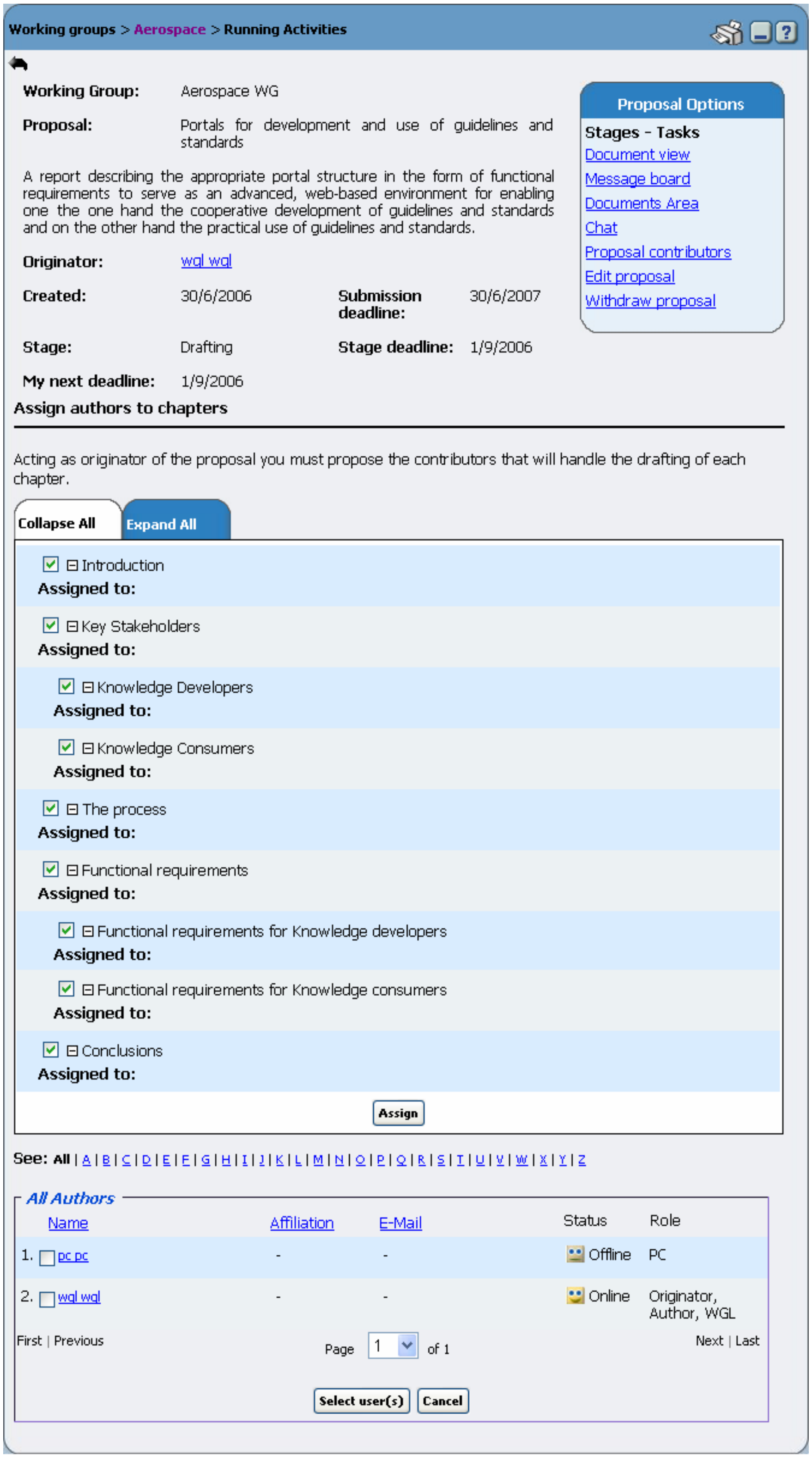


Figure 6:99: Assignment of chapters to authors

Authoring draft proposal

The participants of this task are the contributors of a proposal chapter. Each author enters the chapter authoring area after selecting of a chapter from the proposal table of contents (the chapters assigned to each author are displayed as links). The chapter authoring area can be separated into three parts, as shown in Figure 6:100:

1. **Chapter content editing:** In this area authors can insert chapter content in the form of unformatted text or use the web-editor incorporated to add formatted content. In the case of formatted content, the final chapter text has better quality in terms of presentation. The process of chapter authoring is not completed with the insertion of chapter content. Authors can re-enter the chapter authoring area and update chapter content as long as the "Authoring draft proposal" task is open. A document editing metaphor is provided where users open a document and save the inserted content before exiting the application.
2. **Chapter Authors:** From this region the authors participating to the drafting of the specific chapter are displayed along with the state of each author's contribution. Each author can use the functionality provided to mark her / his contribution as pending or completed. When all users have completed their contributions to chapter content the chapter is marked as completed to the proposal table of contents. The Originator responsible for completing the authoring of the draft proposal can then view chapter status and decide about the closing of the "authoring draft proposal" task.
3. **Reviews:** This area displays the reviews made by proposal contributors in the various reviews phases during the drafting of a proposal.

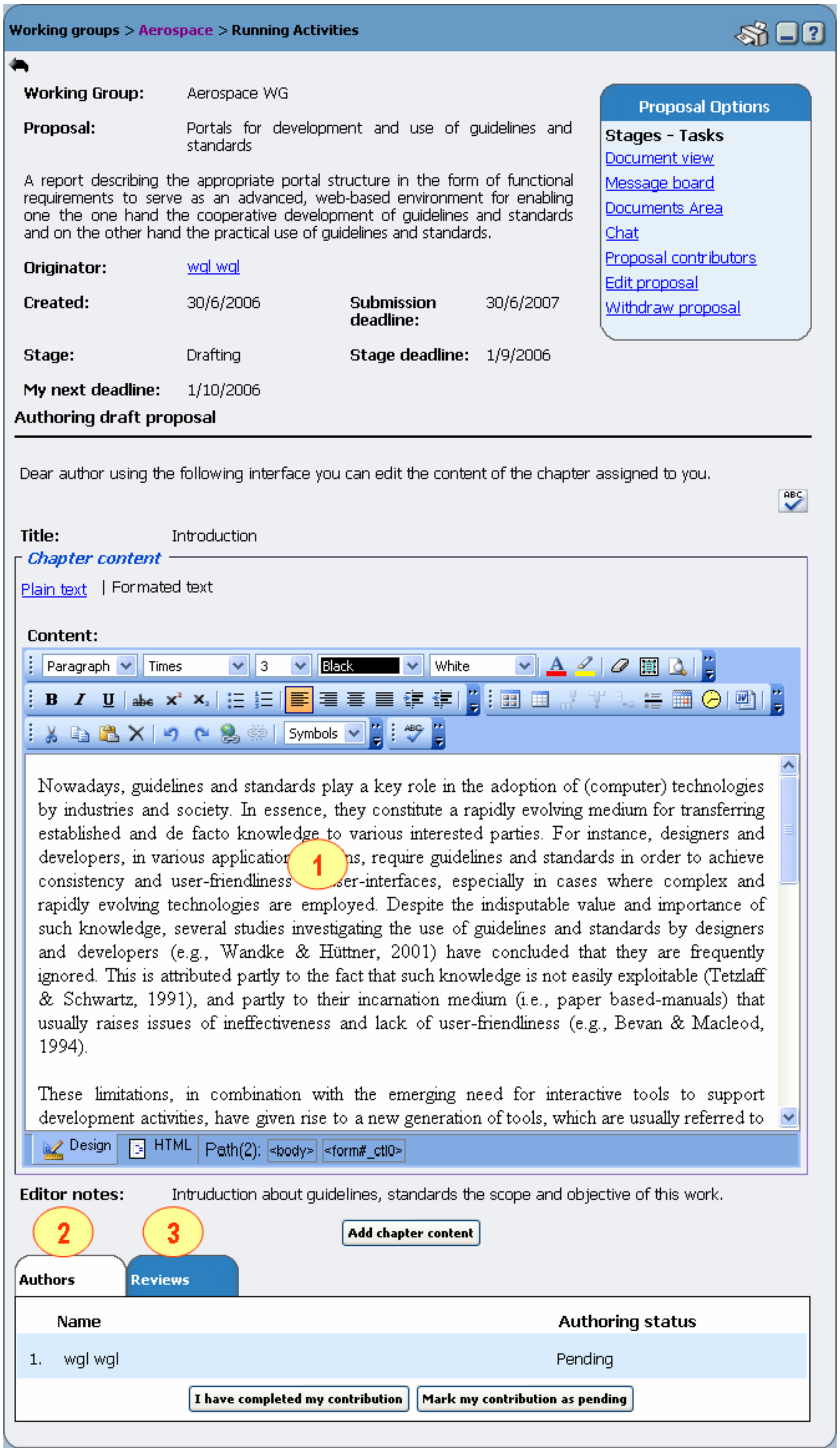


Figure 6:100: Add chapter content

Internal review

The next stage of the proposal preparation is Internal review. To complete this stage, the following tasks are carried out (see Figure 6:101):

- Assign deadlines
- Comments to authors per chapter
- Address comments
- Suggestions to NMC Leader
- Acceptance decision
- Get informed about internal review outcome

Figure 6:101: The internal review stage tasks

Assign deadlines

The objective of this task is to assign deadlines to the tasks contained in the Internal review stage, thus generating the stage time table.

Comments to authors per chapter

In this stage the WGL reviews the proposal document and provides comments to be addressed by chapter authors. The entrance point of this activity is the proposal table of contents shown in Figure 6:102.

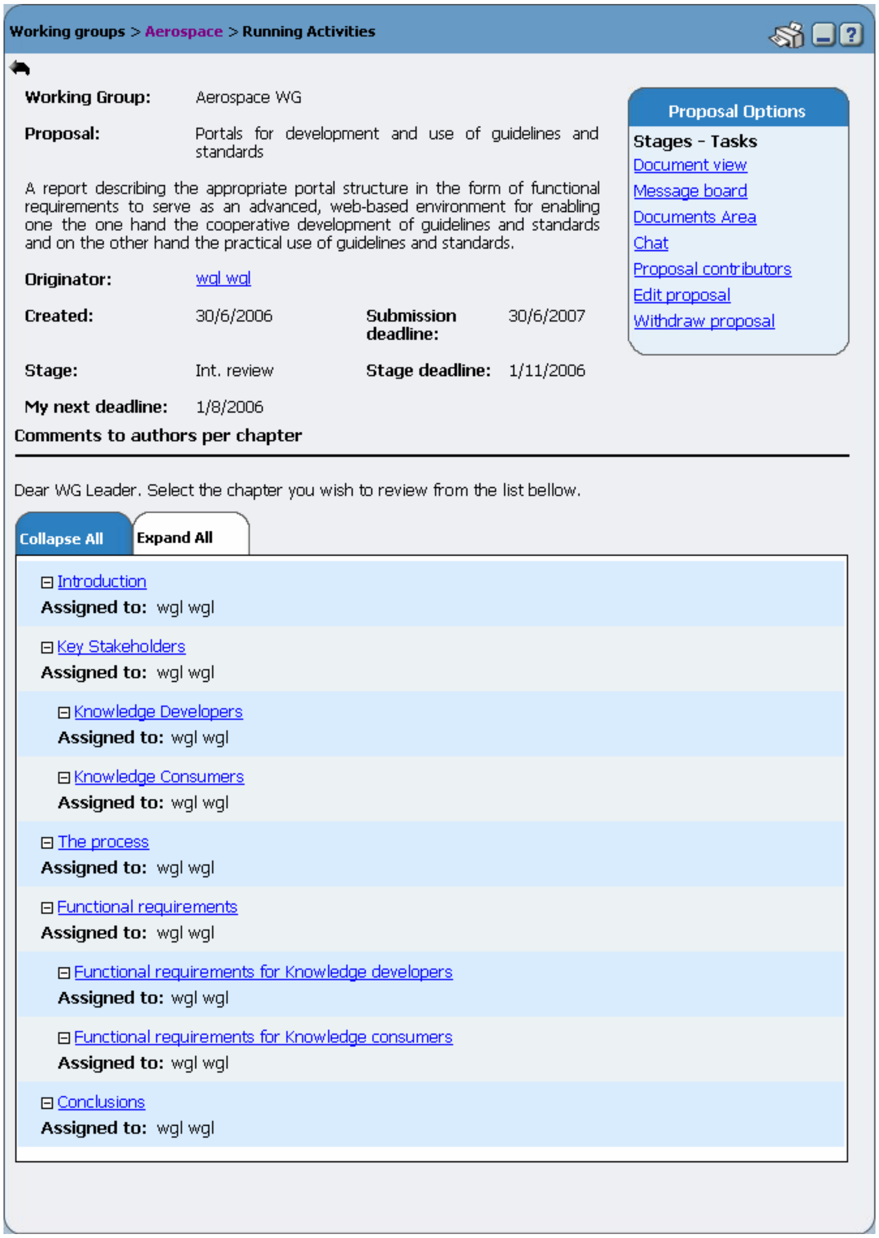


Figure 6:102: Selecting the chapter to review

The reviewing area is presented upon selection of a chapter from the table of contents. This area contains two tab pages, one representing the chapter content and the other containing the comments made by reviewers.

Figure 6:103: Chapter review area

The WGL can view the chapter content and use the reviewing functionality to post comments and suggestions, as shown in Figure 6:104. These comments are added to the reviews tab and are to be used as feedback to chapter authors.

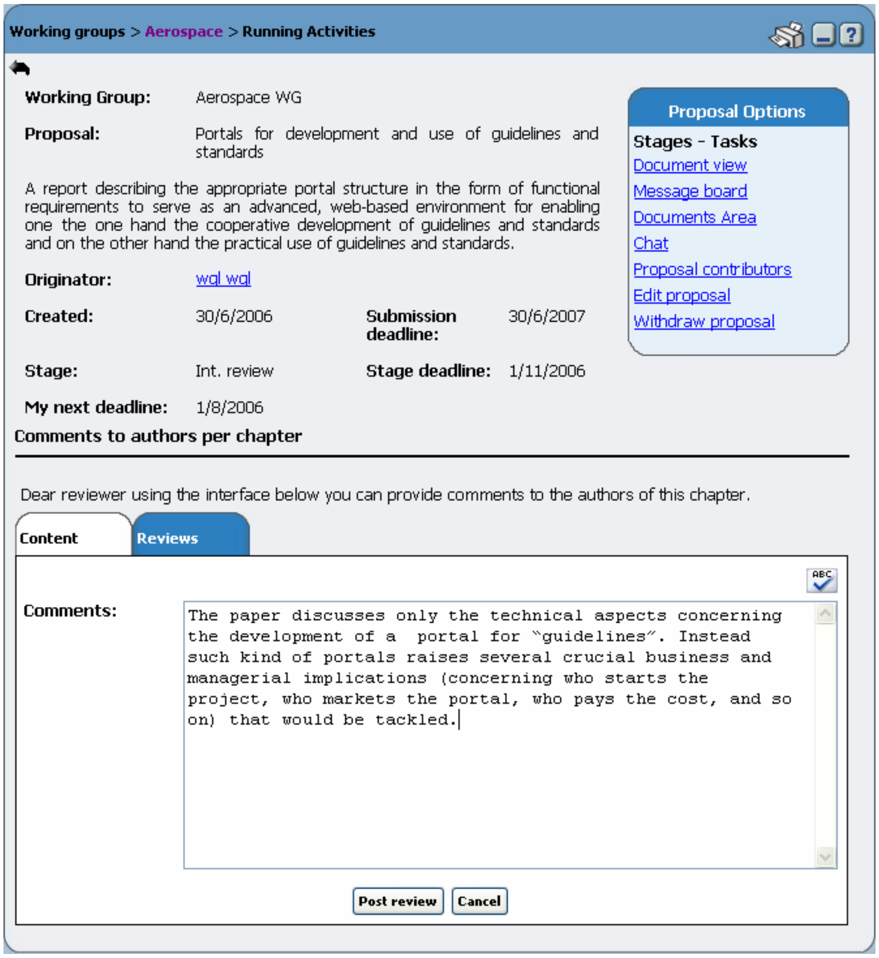


Figure 6:104: Posting comments to chapter content

Address comments

In this phase, proposal authors address the comments made by WGL. The entrance point of this task is the proposal table of contents (chapter assigned to each user are displayed as links). The selection of a chapter for the proposal table of contents displays the chapter's editing area, shown in Figure 6:105. This area contains the chapter content in editable form, followed by the comments submitted by WGL. Users can view the comments and alter the chapter text accordingly. The comments incorporated can be marked as addressed using the build-in functionality.

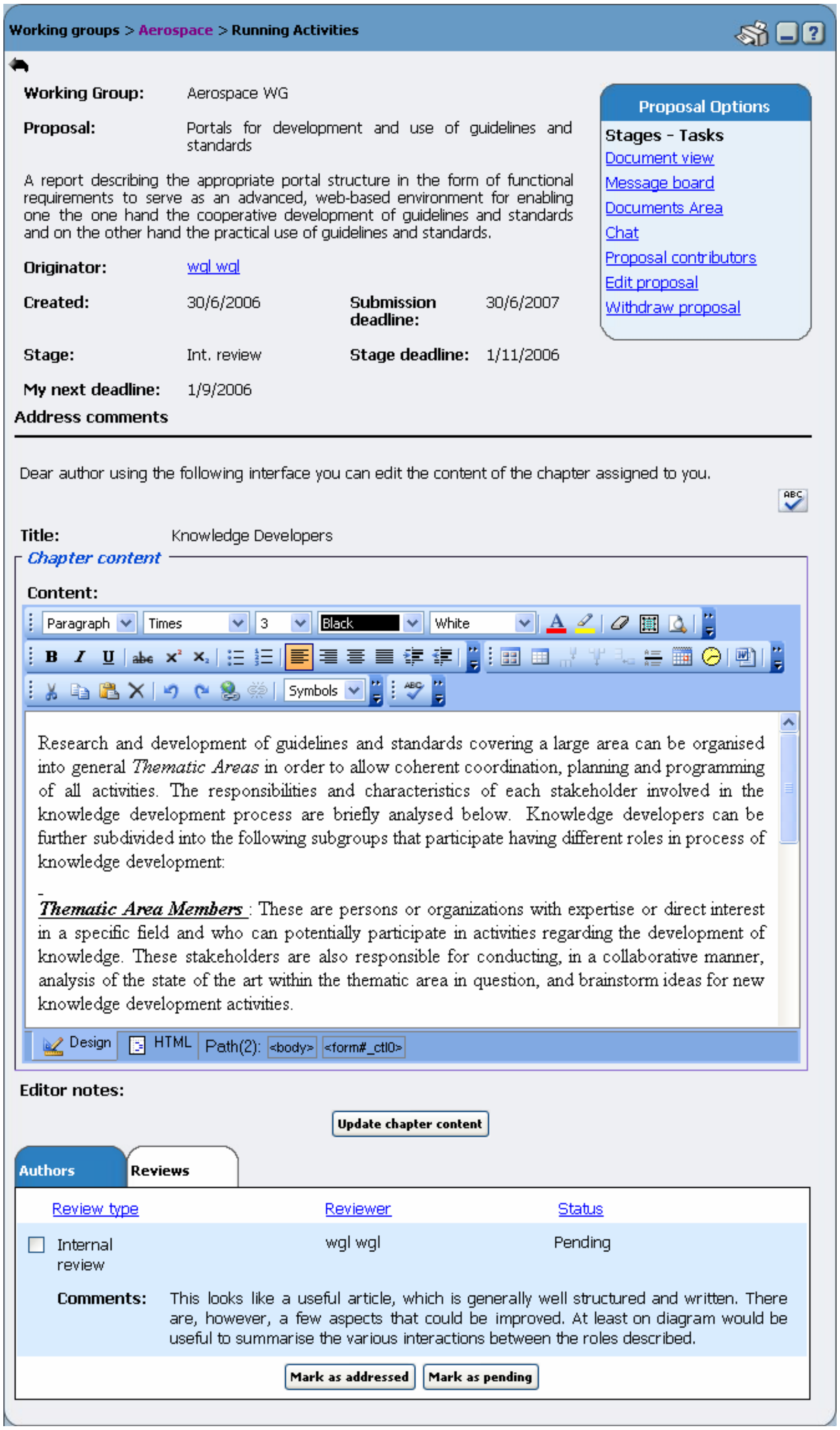


Figure 6:105: The chapter editing area

Suggestions to NMC Leader

The completion of the comments addressing task results to a report that incorporates the comments submitted by WGL. This task requires from the WGL to provide suggestions to the NMC Leader regarding the acceptance or not of the proposal document. Suggestions should be based on the evaluation of the current version of the proposal report after the incorporation of WGL comments. To do so, WGL is provided with an interface for submitting suggestions, as shown Figure 6:106.

Figure 6:106: Providing suggestions to NMC Leader

Acceptance decision

Based on the suggestions submitted by WGL, NMC Leader decides about the acceptance of the proposal. The interface provided to the NMC Leader for deciding is presented in Figure 6:107. The comments made by the WGL are presented followed by the rationale of the NMC Leader's decision. NMC Leader needs to provide a rationale for the decision taken and select among accepting or rejecting the proposal.

Figure 6:107: Deciding about proposal acceptance

Get informed about internal review outcome

This task aims at informing the Originator and the WGL about the internal review outcome. This can be accomplished by displaying the decision made by the NMC Leader followed by the rationale of the decision, as shown in Figure 6:108.

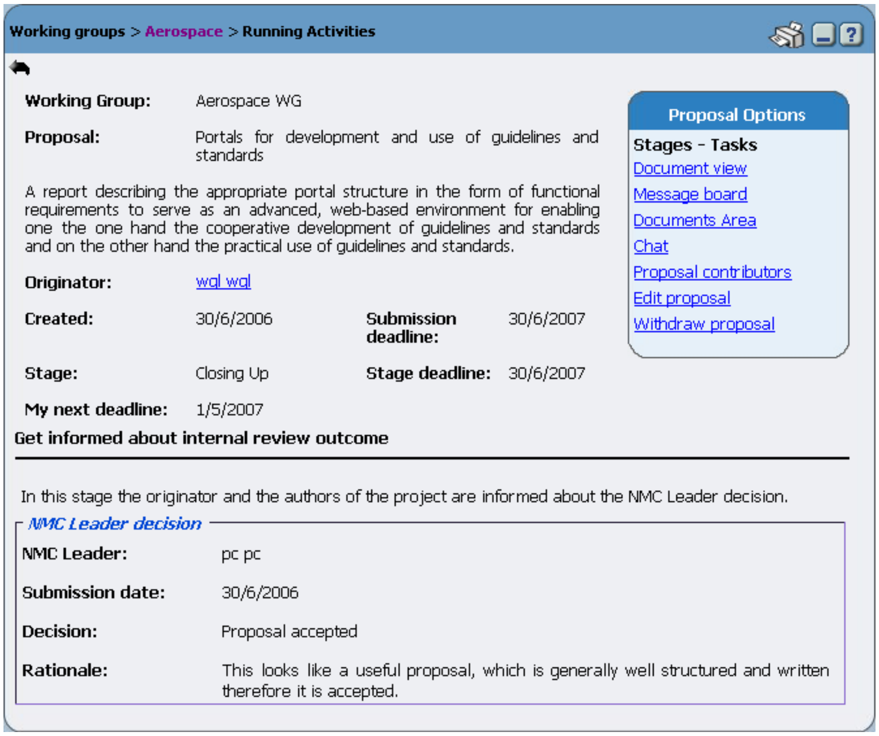


Figure 6:108: Getting informed about internal review outcome

IP review

The next stage of the proposal preparation is IP review. To complete this stage, the following tasks are carried out (see Figure 6:109):

- Assign deadlines
- Invite IPs
- Review proposal
- Address comments
- Rationalise comments and rates
- Suggestions to NMC Leader according to IP review results

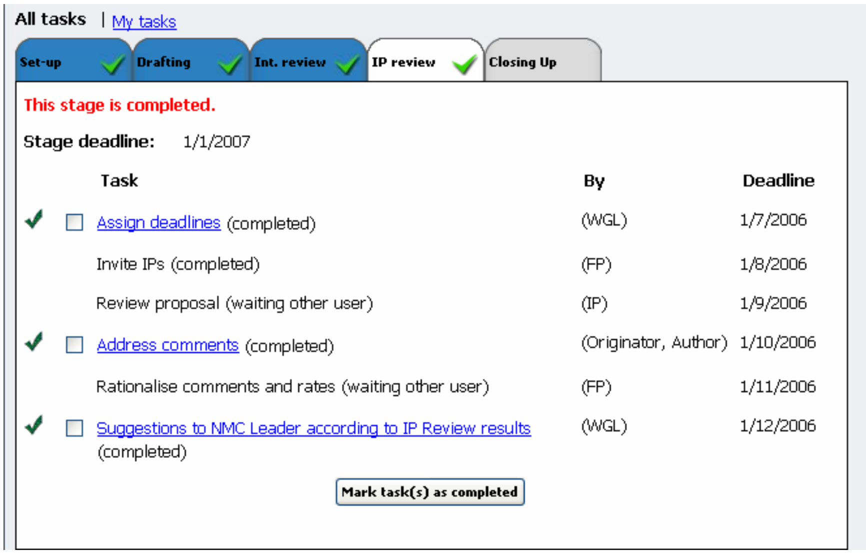


Figure 6:109: IP review stage tasks

Assign deadlines

The objective of this task is to assign deadlines to the tasks contained in the IP review stage, generating the stage time.

Invite IPs

In this stage, the FP acting as contact person to the WG's IPs invites the IPs who will participate in the IP review. By selecting this option, a list of all the WG subscribed participants appears, as shown in Figure 6:110. FP selects the participants to be invited. An invitation notification is submitted to all the invited members. Upon acceptance of this invitation, the IPs can access the proposal and the FP is notified about their decision.

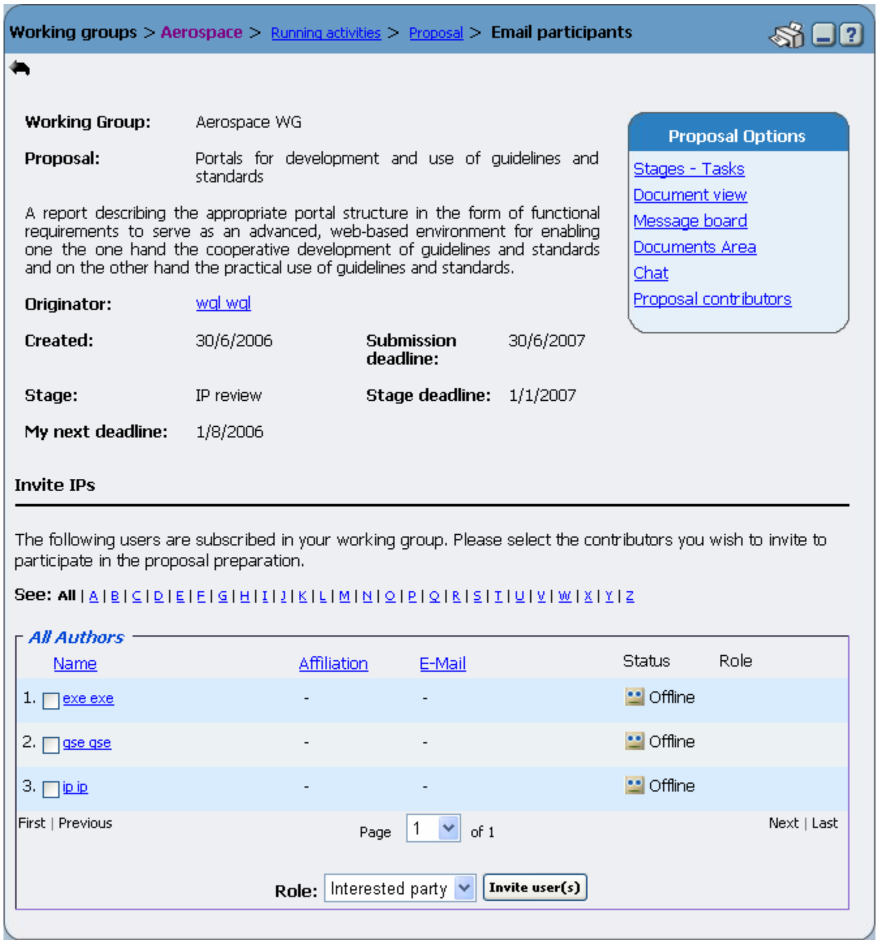


Figure 6:110: Inviting IPs

Review proposal

This task aims at gathering comments on the proposal from IPs. This task is accomplished in a similar way to the reviewing process described in the "Comments to authors per chapter" task. The entrance point of the reviewing activity is the proposal table of contents. The selection of a chapter displays the reviewing area, containing the chapter content, the reviews posted and the reviewing functionality. IPs access chapter content and submit their comments using the reviewing functionality.

Address comments

In the context of this task, the comments submitted by IPs are incorporated in the content. The initiation of this task alters the completion state of proposal chapters. The chapters where reviews were submitted are marked as not completed in the proposal table of contents. Additionally, through this task authors regain access to the content of their assigned chapters in order to make the appropriate corrections according to the submitted comments. This is typically achieved through selecting of a chapter from the proposal table of contents and editing its content from the chapter editing area. Addressed comments can be marked as such by using the functionality provided by the reviews section of the editing area.

Rationalize comments and rates

The FP responsible for inviting IPs has the additional responsibility to rationalize the comment submitted during the IP review. This tasks aims at providing WGL feedback about the potential impact of the proposal to the target user population. FP access the proposal content along with the IP comments and submits the comments rationalisation report as shown in Figure 6:111.

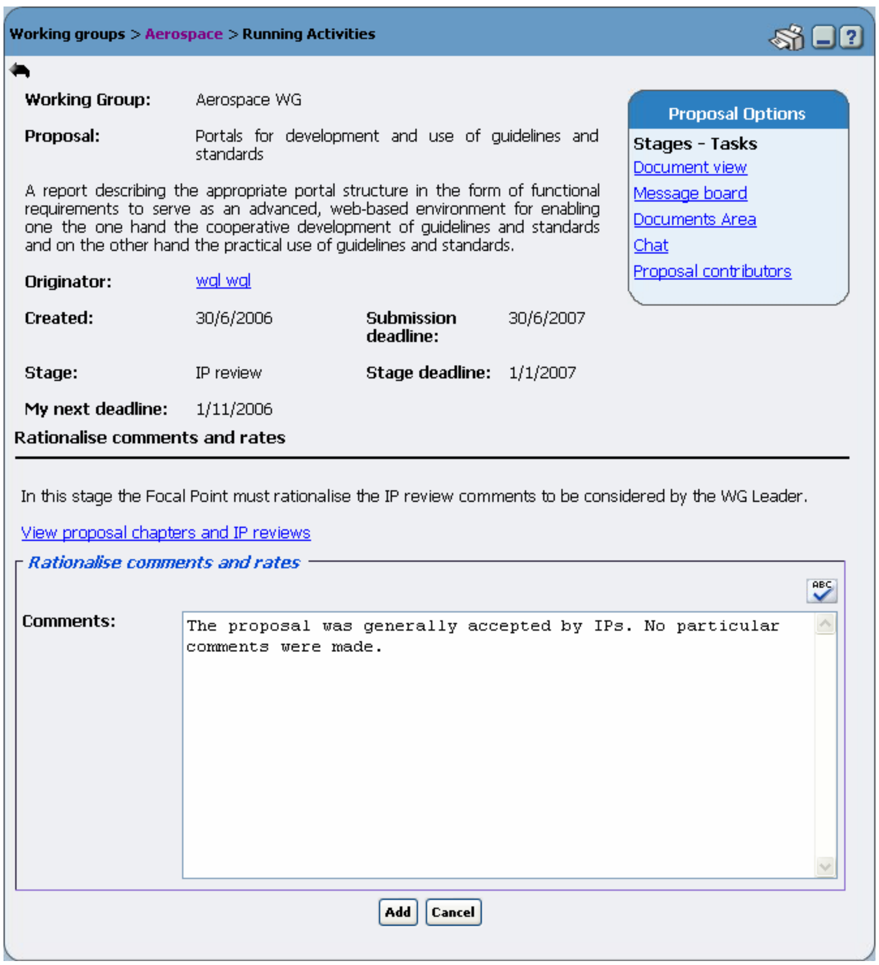


Figure 6:111: Rationalize comments and rates

Suggestions to NMC Leader according to IP review results

In this stage, the WGL provides suggestions to NMC Leader according to the IP review results. These suggestions will be used by the NMC Leader in order to decide about the acceptance of the proposal. The interface provided to WGL to provide comments to NMC Leader is displayed in Figure 6:112.

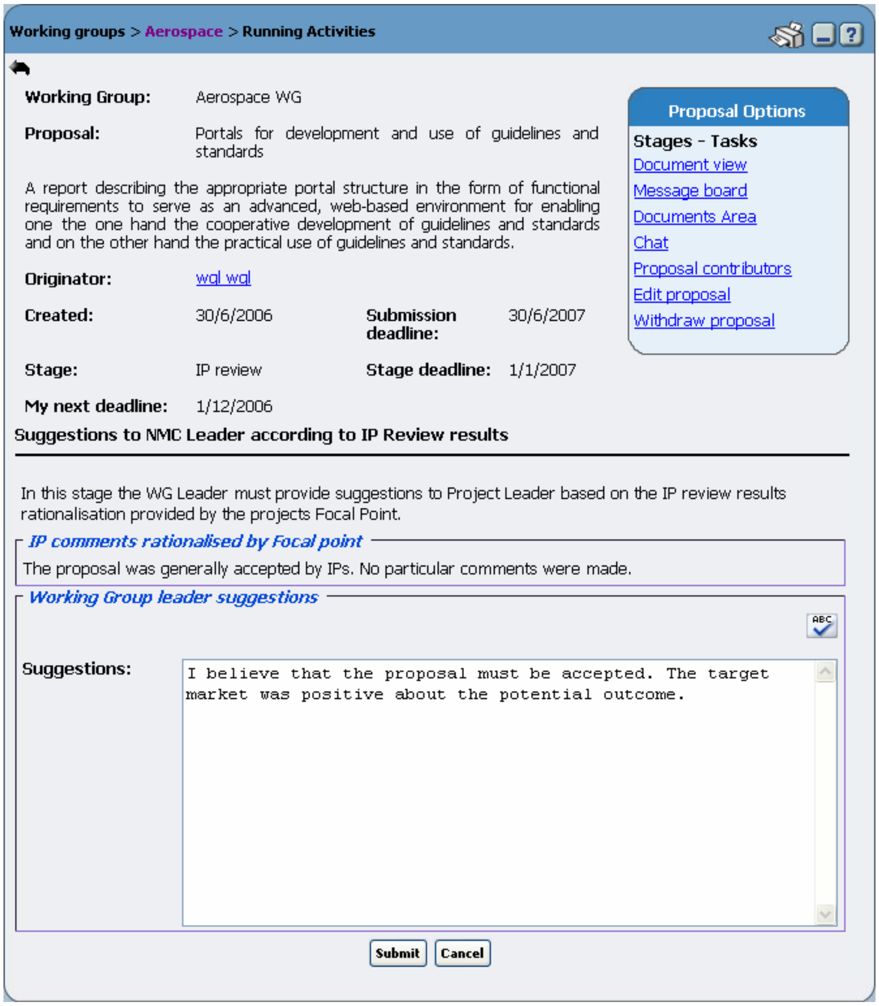


Figure 6:112: Providing suggestions to NMC Leader regarding IP review results

Closing up

This is the final stage of the proposal preparation. To complete this stage, the following tasks are carried out:

- Assign deadlines
- Acceptance decision
- Get informed about final decision
- Publish proposal

- Initiate project

Assign deadlines

The objective of this task is to assign deadlines to the tasks contained in the Closing-up stage, generating the stage time table.

Acceptance decision

In this stage the NMC Leader decides about the proposal final approval taking into account the WGL suggestions provided during the "Suggestions to NMC Leader according to IP review results" task. The interface provided to NMC Leader to decide is shown in Figure 6:113. The NMC Leader also needs to provide additional information about the rationale of the decision.

Figure 6:113: Deciding about the acceptance of the report

Get informed about final decision

In this stage the Originator, Authors and WGL are informed about the proposal final approval. The interface provided for this function provides an overview of the decision in terms of rationale, submission date, etc., as shown in Figure 6:114.

Figure 6:114: Get informed about final decision

Publish proposal

A published proposal can be accessed by knowledge consumers through the digital Library and upon subscription to the appropriate dataset. To perform this task the Originator of the proposal is provided with the means to decide whether the proposal should be published to the digital library or not. The resource type assigned to the proposal document during publication varies according to the selected outcome. The publication of the proposal is carried out with the aid of the resource insertion wizard. The information contained in the insertion interfaces are either filled in by default using the proposal details such as the contributors, content, publication date, content, etc., or filled in by the originator as shown in Figure 6:115. The Originator is required to fill in the additional proposal details and to complete the publication of the proposal.

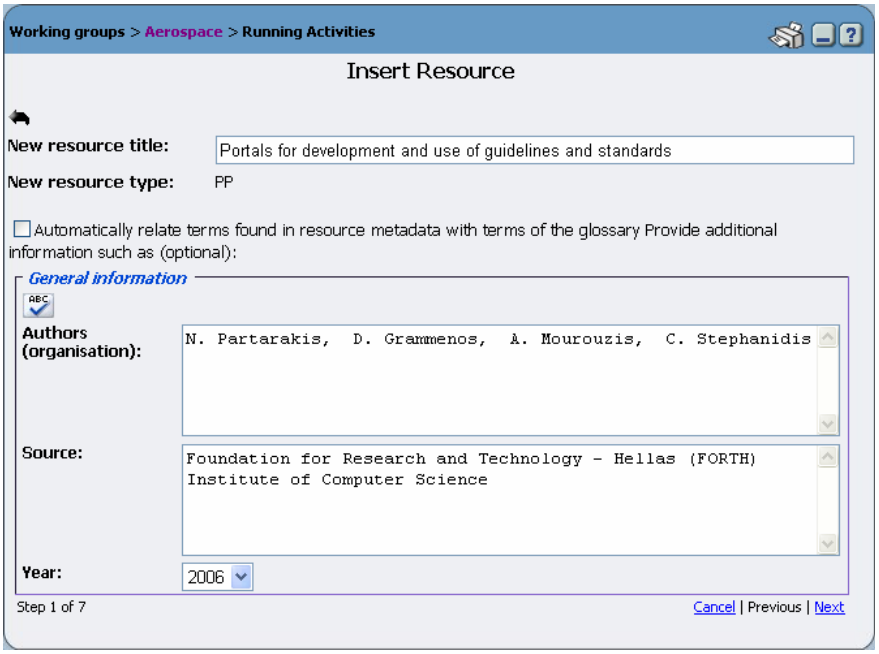


Figure 6:115: Publishing a proposal

Initiate project

In the final task of the proposal the initiation of a project leading to different versions of CDGS reports takes place. The interface used for initiating projects (see Figure 6:116) contains the project details such as the title, abstract that are inherited from the proposal. The WGL is required to specify the project deadline in order to proceed with the initiation of a new project.

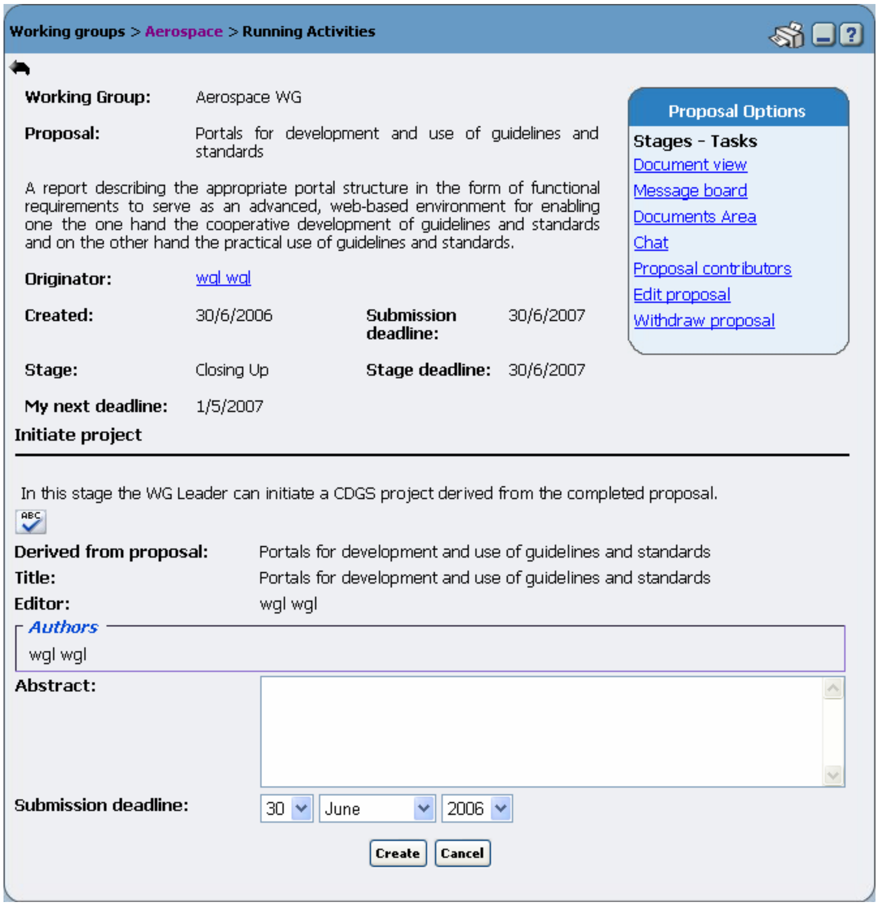


Figure 6:116: Initiate project

6.2.5.10 <u>Projects</u>

6.2.5.10.1 Projects functionality

The initial interface of a project is displayed in Figure 6:117.

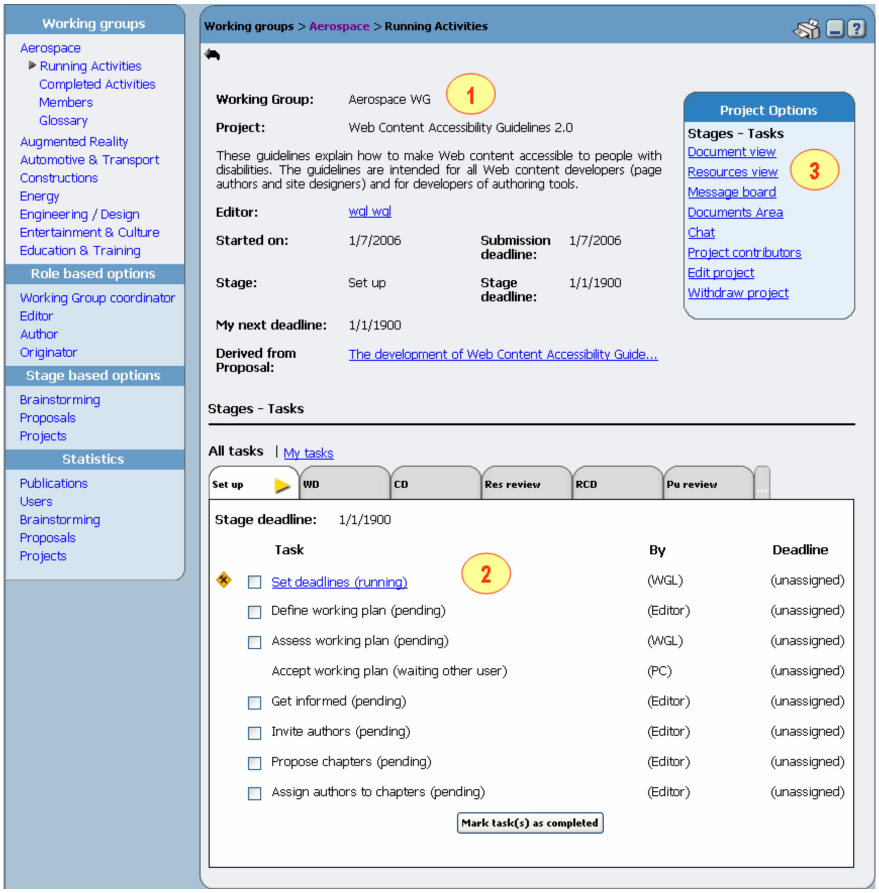


Figure 6:117: The initial interface of a project

Three distinct areas can be identified, and namely:

1. Project details
2. Project selected option functionality
3. Project options

Each of the aforementioned areas is presented in depth in the following sections.

Project details

This area constantly appears while working in a project, and provides information about the project, such as:

4. Title
5. Abstract
6. Editor
7. Creation date
8. Submission deadline

9. Current stage
10. Stage deadline
11. User's next deadline (different for each user represent the deadline of the current task that a user must perform)
12. Derived proposal (The proposal under witch the project was initiated).
13.

Project selected option functionality

This region presents the content of each option selected from the Project Options section.

Project options

This region constantly appears while working on a project, providing the different navigation options according to the role assignment of each contributor. There are two different setups of navigation options, one for the Editor and one for all the other participants. The options available to the project Editor are presented in Figure 6:118.

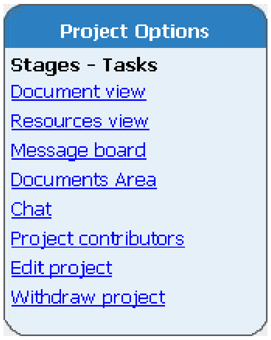


Figure 6:118: The options provided to project editor

On the other hand, the options provided to all the other project contributors are shown in Figure 6:119.

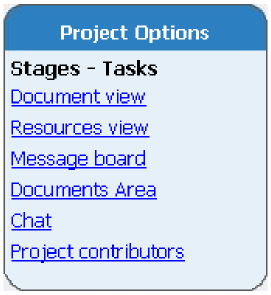


Figure 6:119: The options provided to all project contributors that are not editors

Stages-Tasks

This option provides access to the stages and tasks that must be carried out to generate a CDGS report, as shown in Figure 6:120. In this interface, the stages are displayed as tabs, and within each tab the tasks foreseen for each stage are shown. For each task in the task list, the following information are presented:

- Task name
- User role responsible for completing the task
- Task deadline

According to the role assignment of each contributor, checkboxes appear next to the tasks that can be completed by the contributor currently browsing the interface.

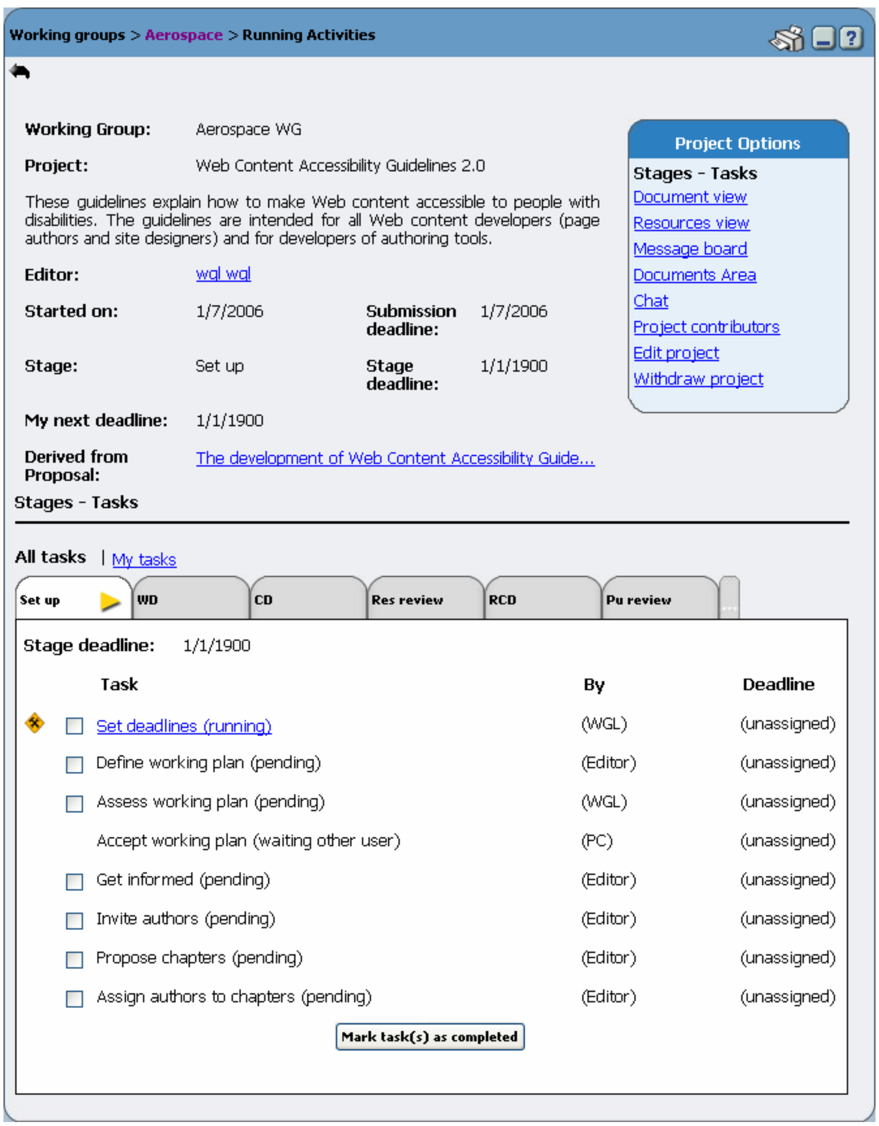


Figure 6:120: The project Stages-tasks interface

Document view

The Document view provides a document-like overview of the project report under development throughout all the stages of the project development life cycle. Using this option, each contributor can gain access to the full version of the report and not only to the areas of personal interest. The document view of a project report is generated using the chapters contained in the report table of contents and the resources that represent the content of each chapter using the process presented in Figure 6:121.

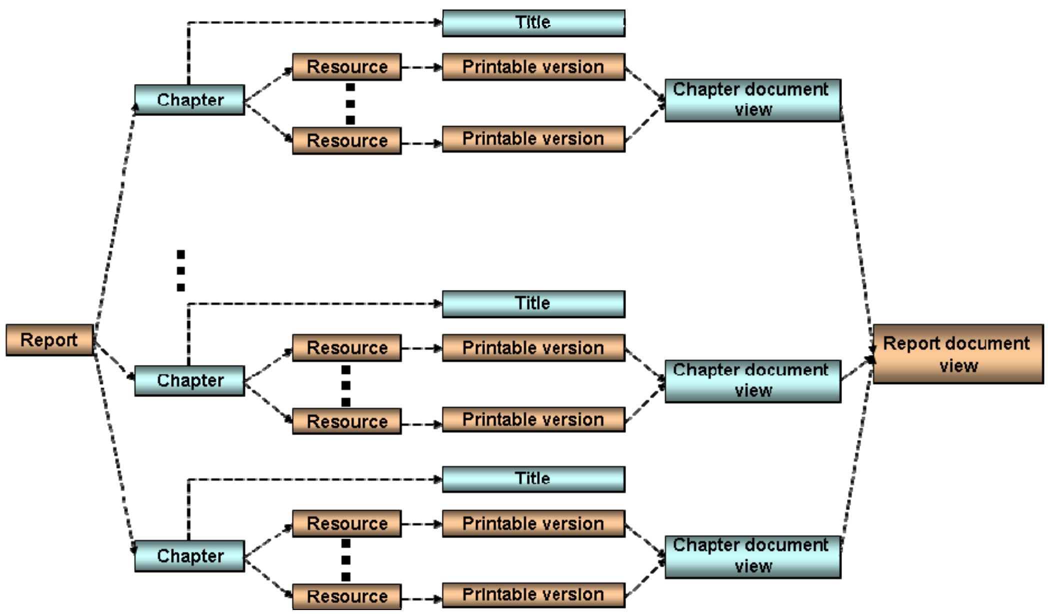


Figure 6:121: The resource document view generation

In the document view interface (see Figure 6:122) the report table of contents is presented in the form of links navigating to the actual content of each chapter. Additionally, the content of each chapter is followed by a link that navigates to the table of contents.

Figure 6:122: The document view of a project

Resources view

The contents of each chapter of a project report are resources of the digital library. Therefore it is necessary to maintain a resources view of the project report for quick access to individual items of a chapter. Figure 6:123 provides an overview of the report equivalent that is structured based on the resources contained in each chapter of the report.

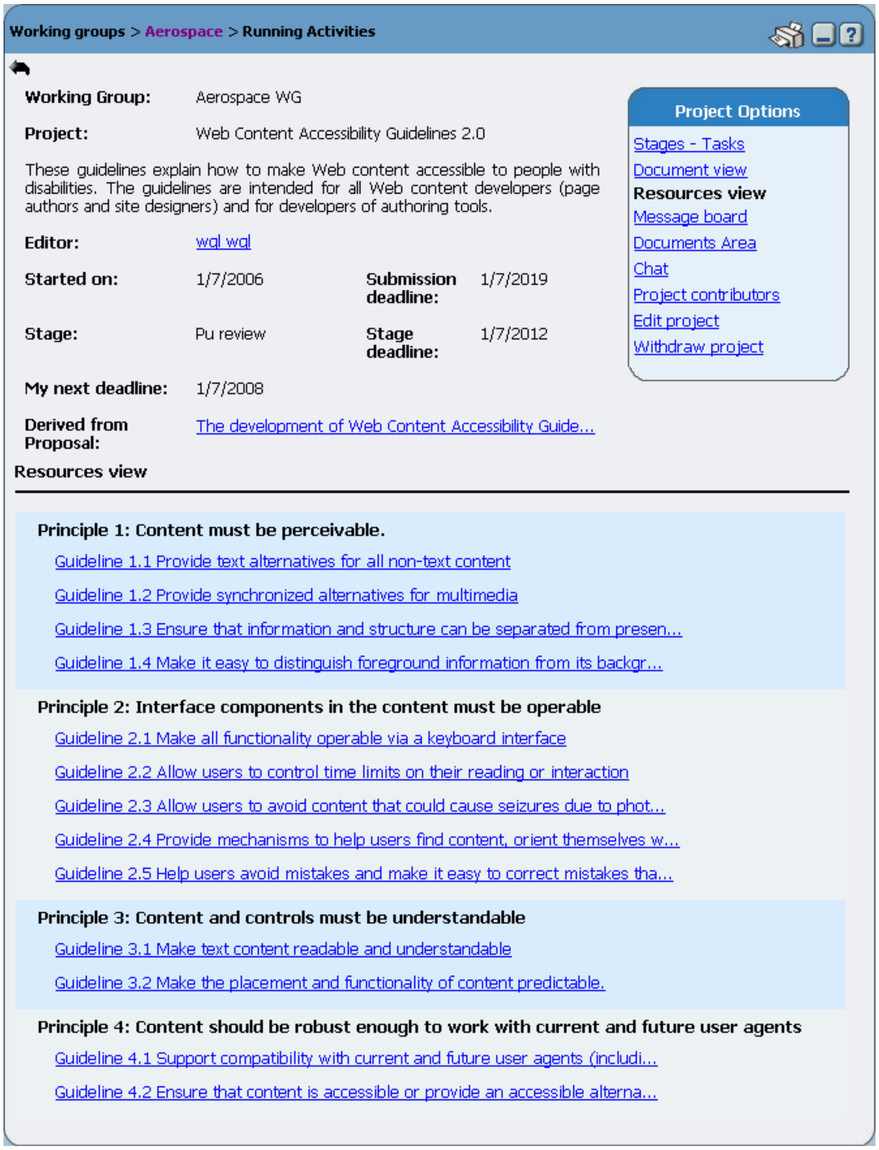


Figure 6:123: The resources view of a project

Message board

The project message board provides the field where the major part of interaction and communication among project contributors take place. With the help of this facility, contributors can communicate and discuss issues related to the various stages of the project. The discussions in the message board facility are organized in a number of discussion topics.

Documents Area

The project document area acts as a common repository of documents for project contributors. With the help of this facility, the editor of the project report can upload useful reference material to be considered by project contributors.

Chat

The project chat is the field where project contributors online at a specific time can participate into real time discussions concerning the project.

Project contributors

The project contributors' facility provides an area where the Editor of a project can administer the contributors (see Figure 6:124). The administration tasks that can be performed in this area are the invitation of new members and the removal of inactive ones. Additionally, from this area all project contributors can access a list of all the contributors participating in the project report preparation, along with the role assignments of each contributor and the related personal information.

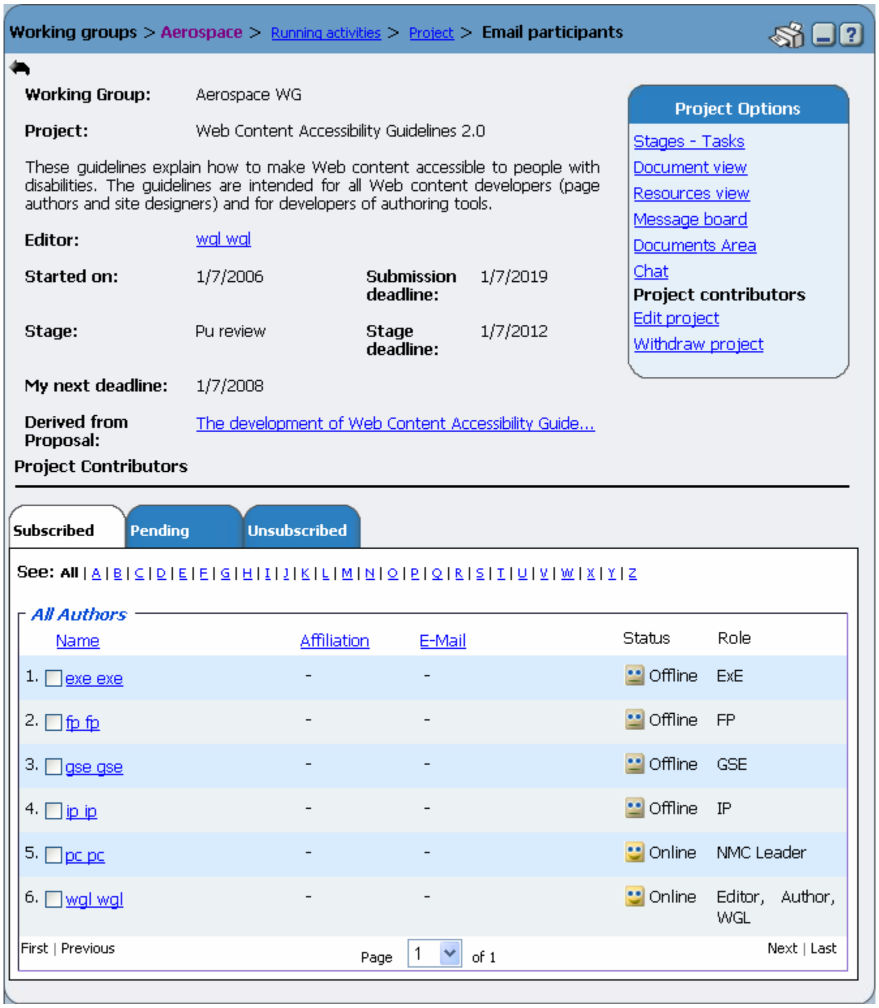


Figure 6:124: Project contributors

Edit project

The Editor of a project through this option can edit project information such as the title and abstract. Upon completion of this task, the altered information appears in the project details area.

Withdraw project

The editor of a project report can decide to withdraw it in case it is not possible gather sufficient contributions to support the purpose of the report. The process of withdrawal is presented in Figure 6:125. Withdrawn project can be accessed through the WG completed activities.

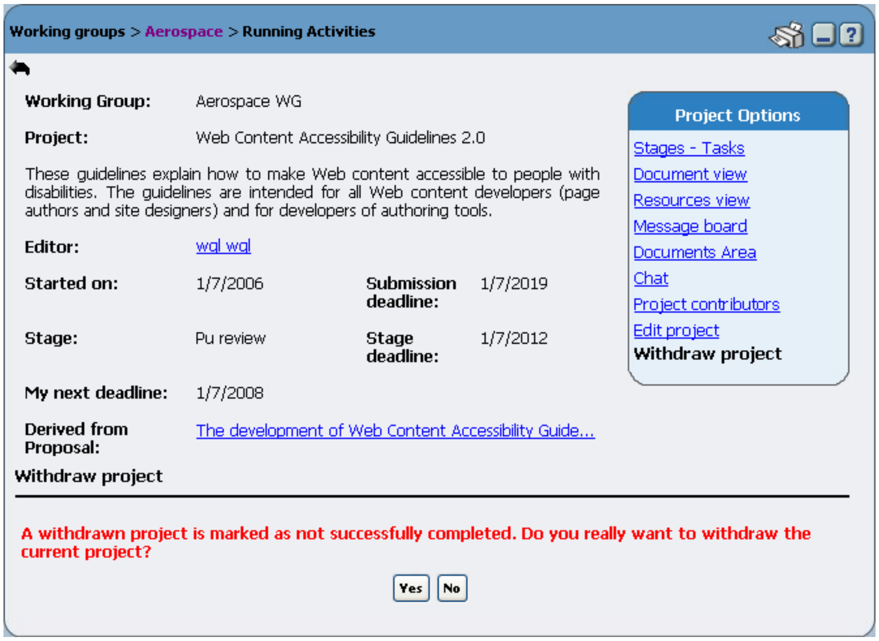


Figure 6:125: Project withdrawal

6.2.5.10.2 Running a project

This section describes the processes involved for creating a CDGS report. More specifically the project phase involves the following stages:

- Set-up
- Working Draft (WD)
- Consensus Draft (CD)
- Revised Consensus Draft (RCD)
- Public Review
- Closing Up

The initial task involved in each of the aforementioned stages is the assignment of deadlines to the tasks contained in each stage, thus generating the stage time table. This timetable will be subsequently used to inform all project contributors about the time limit set to their activities. An example of this process is presented in Figure 6:126. The following sections present an in depth description of the tasks involved in each stage of a project.

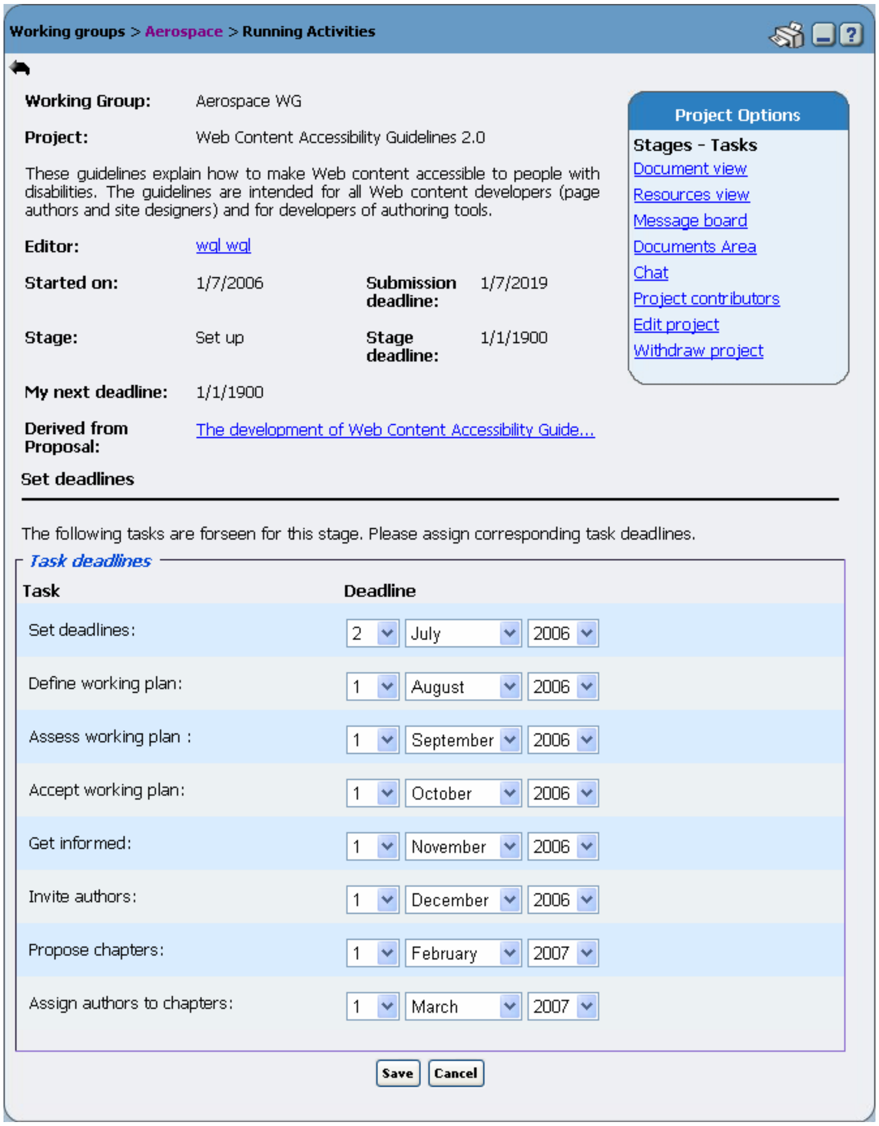


Figure 6:126: An example of assigning deadlines to the Set–up stage tasks

Set up

The first stage of the project is the Set up. To complete this stage, eight steps need to be carried out (Figure 6:127), and namely:

- Set deadlines
- Define working plan
- Assess working plan
- Accept working plan
- Get informed about working plan approval
- Invite authors

- Propose chapters
- Assign authors to chapters

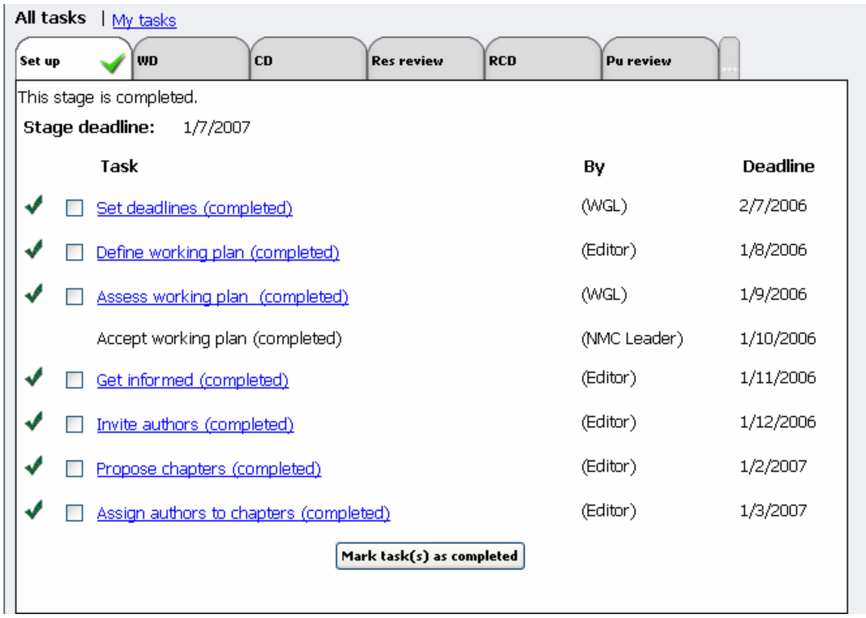


Figure 6:127: The tasks contained in the Set up stage

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the Set up stage, generating the stage time table.

Define working plan

In this stage, the editor of the project formulates an appropriate work plan. This process entails the refinement of a project outcome and the additional assignment of deadlines to the stages foreseen for the selected outcome, as shown in Figure 6:128. The possible outcomes of a project can be one of the following:

- **Technical specification:** Skip Restricted review, RCD, Public review, Closing up
- **International Workshop Agreement:** Skip Public review
- **Guidelines:** Skip Restricted review, RCD, Public review, Closing up
- **Recommendations for standards:** None skipped
- **Draft standard:** None skipped
- **Internal standard:** Skip Public review

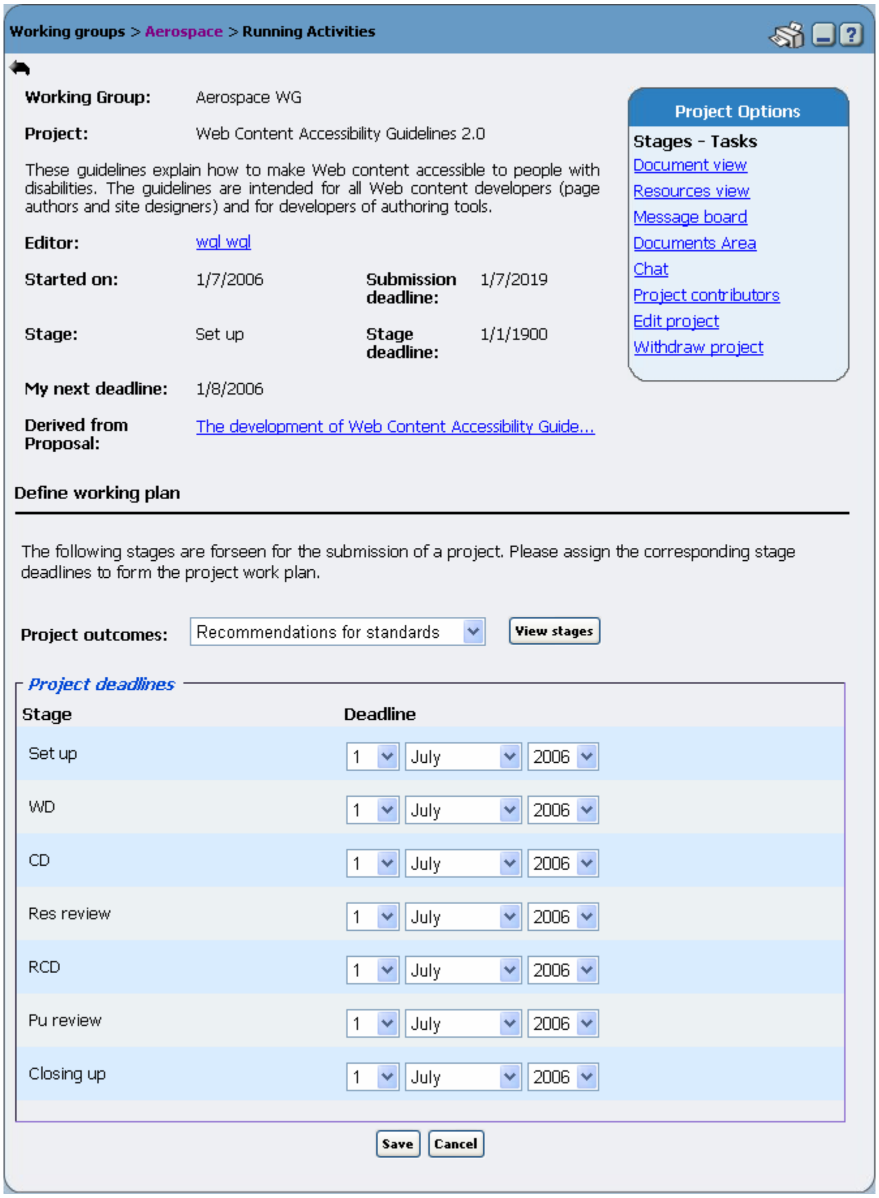


Figure 6:128: Define work plan

Assess working plan

The work plan proposed by project Editor is evaluated in the context of this task by the WGL. More specifically, the WGL gains access to the proposed outcome, the stages involved and the assigned deadlines and after evaluating of the aforementioned information submits comments to be considered by the NMC Leader (Figure 6:129), who has the responsibility of the final acceptance decision.

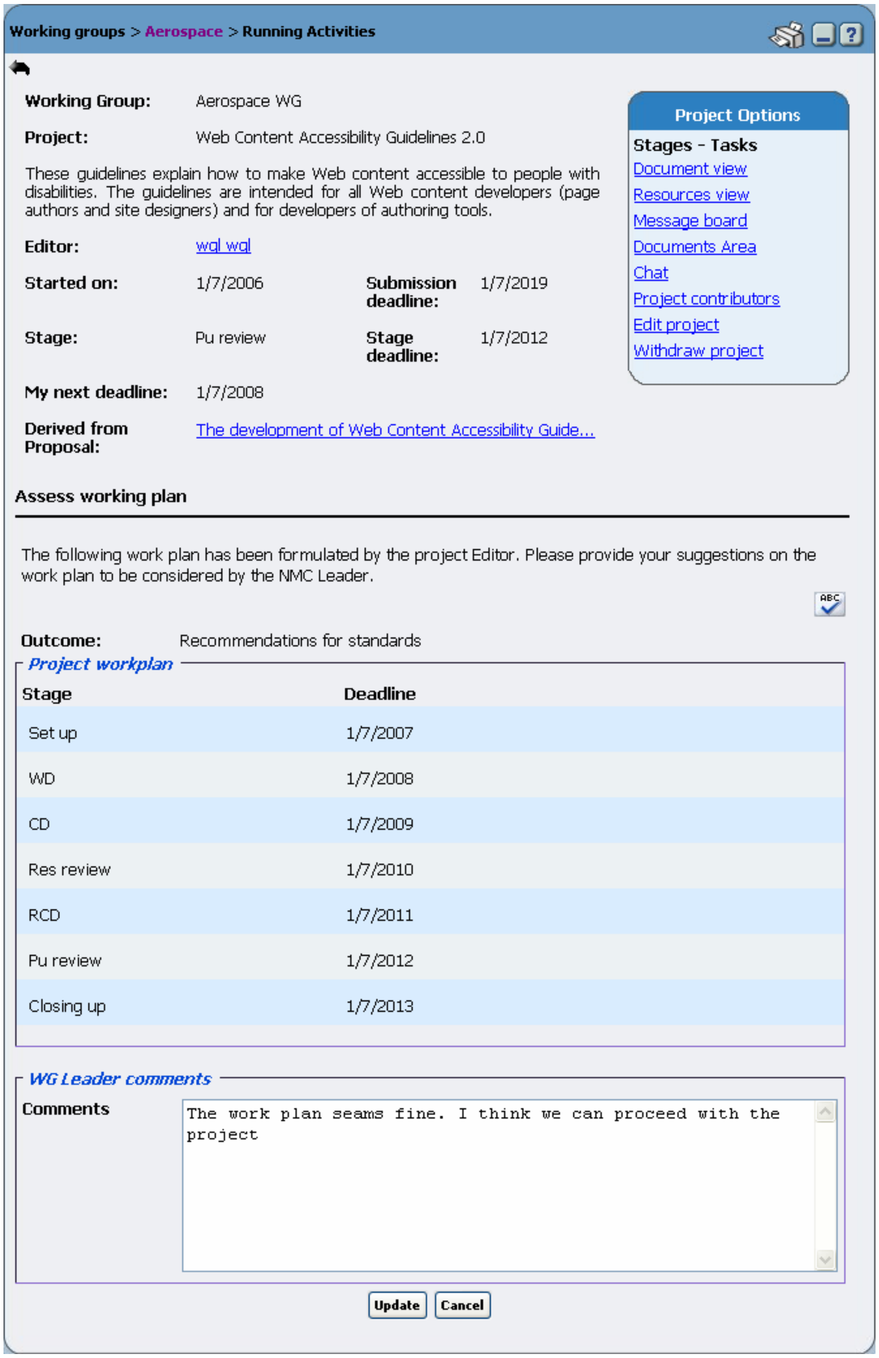


Figure 6:129: Assess working plan

Accept working plan

The NMC Leader, taking into account the comments made by WGL on the proposed work plan, takes the final decision regarding the approval of the work plan, as shown in Figure 6:130. A potential rejection of the work plan by the NMC Leader reinitiates the process of work plan definition and assessment.

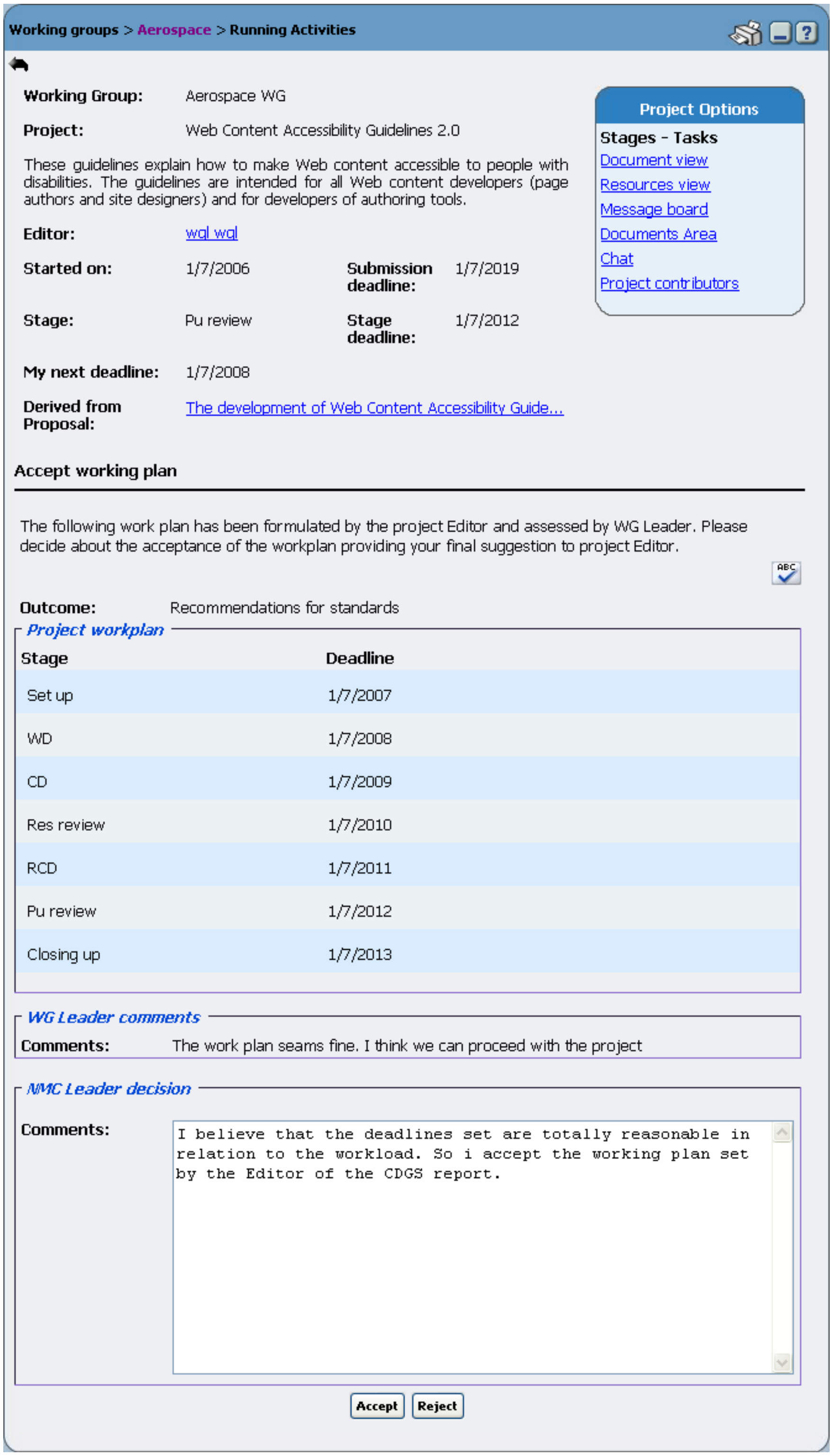


Figure 6:130: Accept Working plan

Get informed about working plan approval

The editor responsible for the formulation of the initial work plan is informed during this task about the decision of NMC Leader. Additionally, this task provides access to the comments made by NMC Leader during the evaluation of the work plan. In turn, the editor of the proposal reformulates the work plan in order to address these comments. This is accomplished by editing the stages deadlines as shown in Figure 6:131.

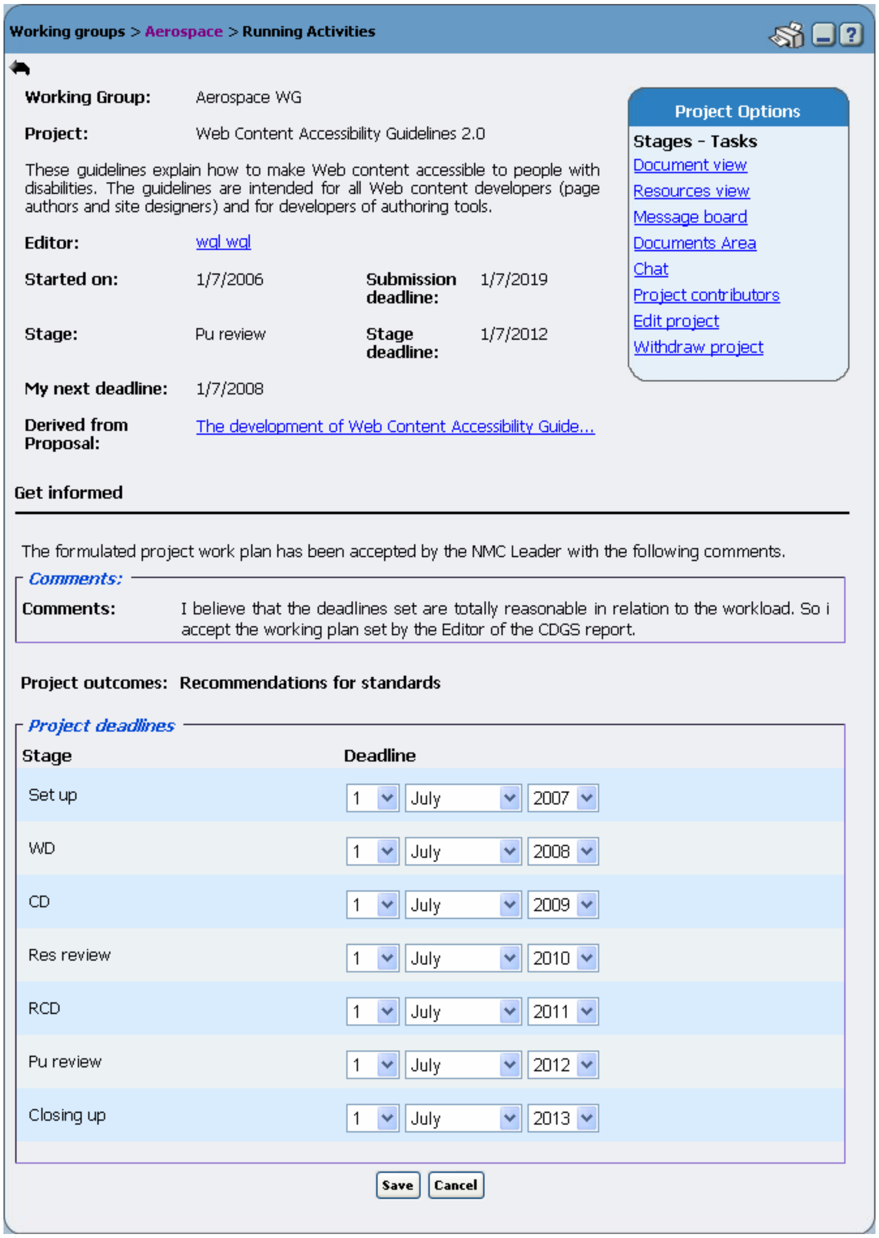


Figure 6:131: Get informed

Invite authors

Each project is assigned with an initial list of contributors during creation. These contributors are the Editor, the WGL, the NMC Leader and the contributors of the derived proposal. The aim of this task is to form the final list of authors by enabling the Editor to invite additional contributors. This task requires from the Editor to select the members to be invited from the available WGMs, and provide their role assignment, as shown in Figure 6:132. After completion of this process, notifications are submitted (via e-mail and through the portal) to the invited members. These members are added to the project contributors list only after acceptance of their invitation. The invitations are accessed through the notifications functionality or through the main page of the project.

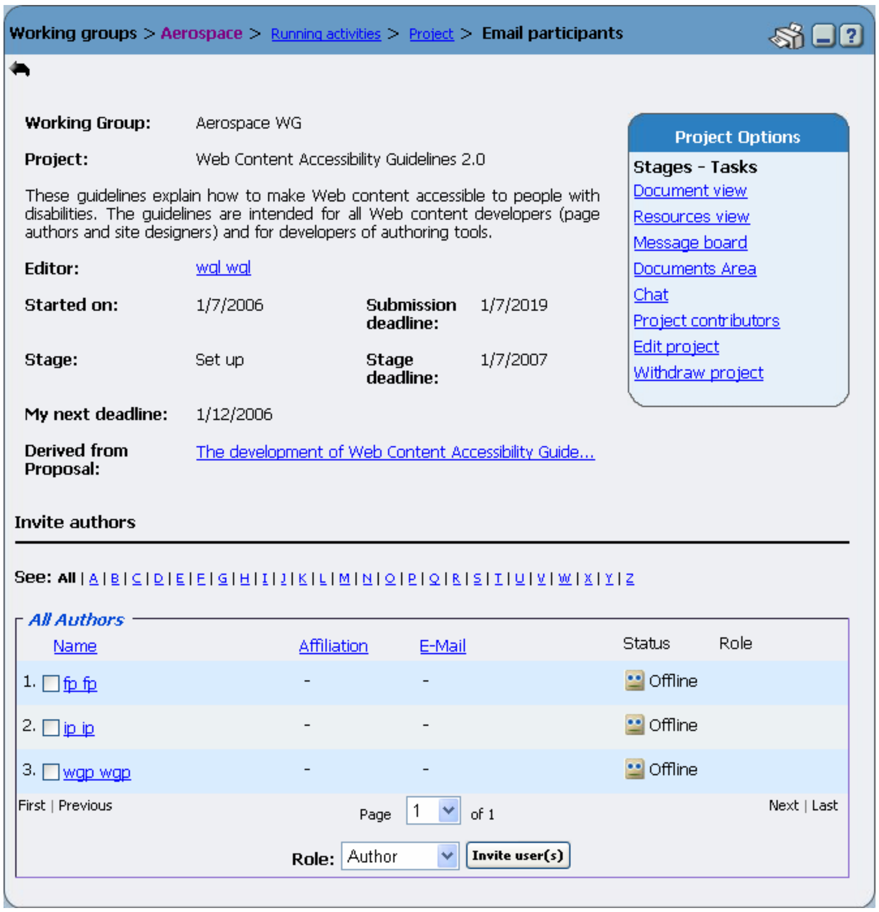


Figure 6:132: Invite authors

Propose chapters

During this task, the project report table of contents is generated. To do so, the Editor proposes the chapters to be included in the final report. The functionality provided to carry out this task supports the creation of an n-level hierarchy of chapters and is similar to the one already presented in the "Propose chapters" task of the proposal, as shown in Figure 6:133.

Figure 6:133: Propose chapters

Assign authors to chapters

The objective of this task is the assignment of individual chapters to project contributors (authors). This task requires first the selection of the chapters to be assigned, and the subsequent selection of the chapter authors, as shown in Figure 6:134. Each chapter can be assigned to more that one authors and each author can participate to the drafting of more than one chapter.

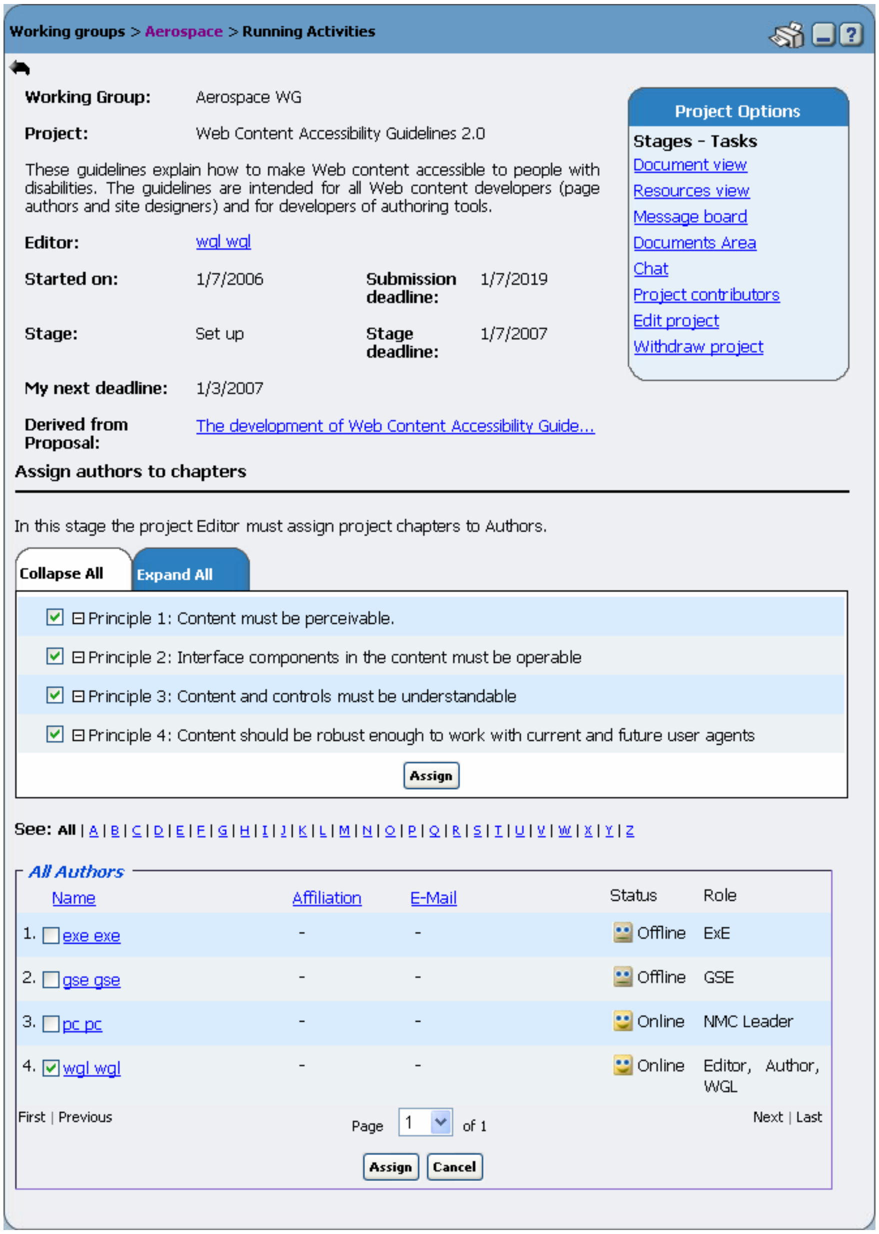


Figure 6:134: Assign authors to chapters

Working Draft (WD)

The next stage of the project is WD. To complete this stage, four steps need to be carried out (Figure 6:135), and namely:

- Set deadlines
- Authoring Working Draft
- Commenting
- Approval

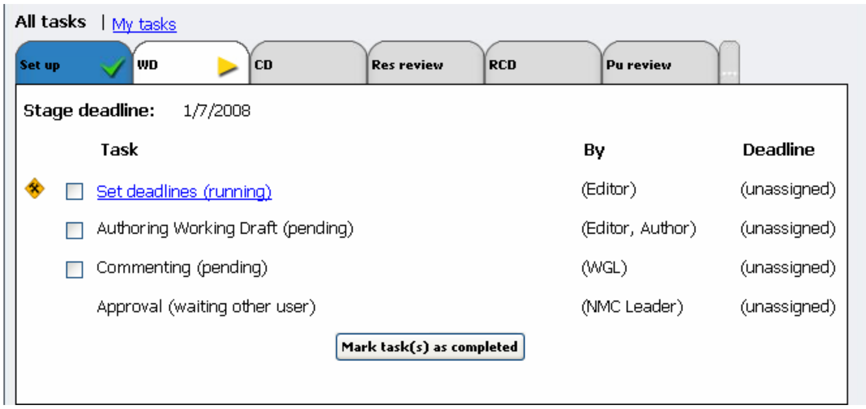


Figure 6:135: The tasks contained in the WD stage

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the WD stage, generating the stage time table.

Authoring Working Draft

During this stage, the editor and authors of the proposal should prepare the working draft version of the CDGS report. Authors through this option gain access to the report table of contents as formulated during the "propose chapters" task. The chapter assigned to each author appear as links in the chapter hierarchy. The editing of chapter content is performed in the chapter editing area displayed after the selection of a chapter from the report table of contents, as shown in Figure 6:136.

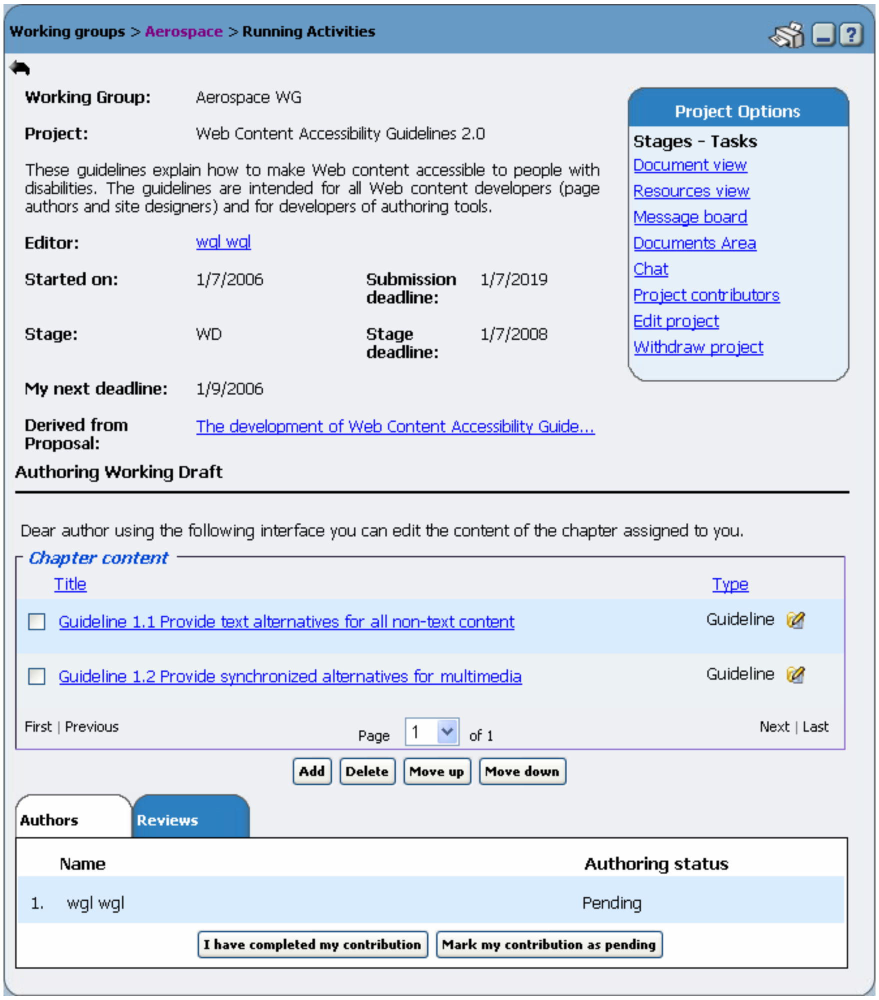


Figure 6:136: The chapter authoring area

This area is divided into three main parts:

- **Chapter content:** In the case of the final project report, the content of each chapter is represented by a numbers of resources of the Digital library. The chapter content area contains a list of resources and additional functionality for adding, removing and editing the ordering of resources. Using this functionality, each Author can insert a new resource to the chapter following the steps defined in the add resource interface.
- **Chapter authors:** This area displays the list of authors participating in the drafting of the specific chapter. Additionally, information about the completion status of each author contribution is displayed. Using this interface, users can mark their contribution as completed. When all authors complete the authoring, the chapter is marked as completed in the project table of contents.

- **Chapter reviews.** This area contains the reviews made by project contributors during the various reviewing phases of the project report.

Commenting

In this stage, the WGL must provide comments regarding the WD version of the CDGS report, as shown in Figure 6:137. These comments are in turn to be considered by the NMC leader for deciding about the report approval.

Figure 6:137: Comments on the WD version of the CDGS report

Approval

During this task, the NMC Leader views the WD version of the report and the comments made by WGL, and decides about the approval of the report, as shown in Figure 6:138. Approval of the report initiates the CD stage of the project. On the other hand, rejection of the WD version of the proposal results in the completion of the project. This project can be accessed through the WG completed activities, marked as "completed rejected".

Figure 6:138: NMC Leader approval

Consensus Draft (CD)

The next stage of the project is CD. To complete this stage, six steps need to be carried out (Figure 6:139), and namely:

- Set deadlines
- External Experts comments
- Guidelines & Standardisation Experts comments
- Author Consensus Draft
- WG Leader comments
- Approval

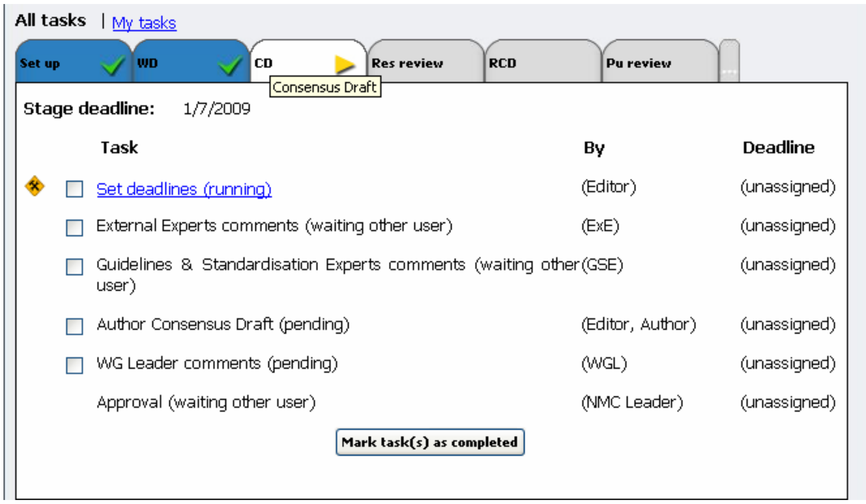


Figure 6:139: The task contained in the CD stage

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the CD stage, generating the stage time table.

ExEs comments

This task aims at gathering comments on the WD version of the report from the ExEs participating in the project. The entrance point of this activity is the project report table of contents shown in Figure 6:140. The reviewing area is presented upon selection of a chapter from the table of contents. This area contains two tab pages, one representing the chapter content and the other containing the comments made by reviewers. ExEs can view the chapter content and use the reviewing functionality to post their comments on individual resources, as shown in Figure 6:141. These comments are added to the reviews tab to be used as feedback to chapter authors.

Figure 6:140: The project report table of contents

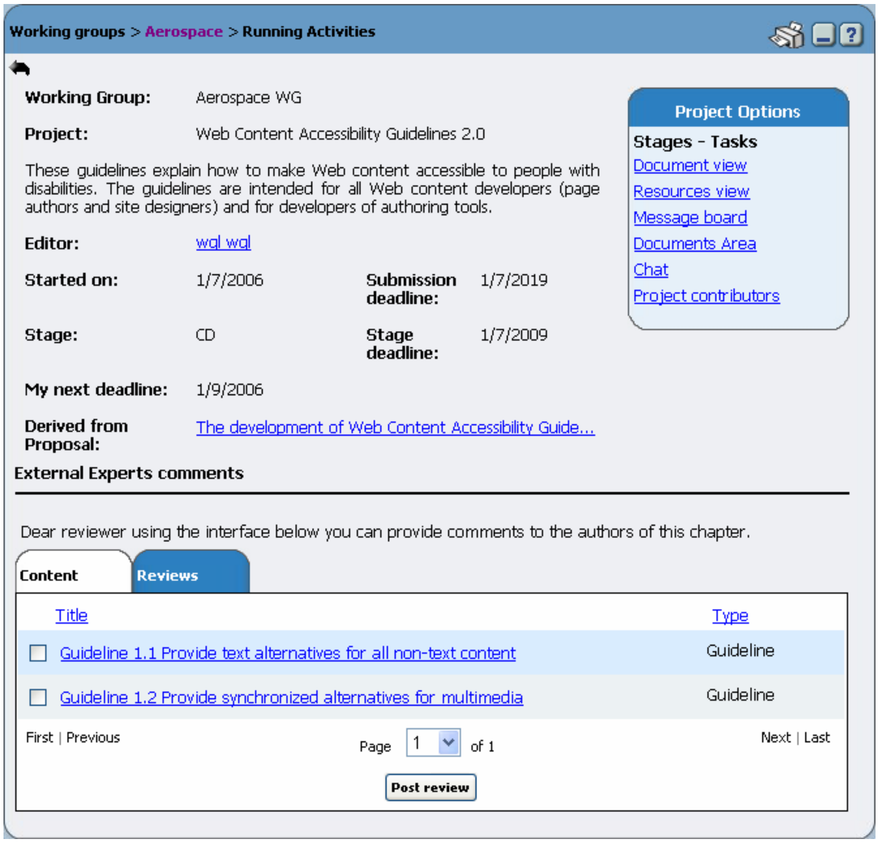


Figure 6:141: The chapter reviewing area

G&S specialists comments

This task aims at gathering comments on the WD version of the report from the GSEs participating in the project. The process of commenting is carried out in the same way described in the case of ExE comments.

Author Consensus Draft

The Consensus Draft is the version of the report that incorporates all the comments made by the WGL, the ExEs and the GSEs specialists. The process of addressing these comments is carried out through the chapter editing area (see Figure 6:142). This area is divided in three main parts:

- **Chapter content:** This area displays the resources added by chapter authors during the drafting of WD. Such resources can be edited in order to address the comments made during the various reviewing phases.
- **Authors:** This area presents all the authors participating in the drafting of the specific chapter. Form this area, each author can mark her / his contribution as completed.

- **Reviews:** From this area authors can access the reviews made to chapter content and that need to be address in order to elaborate the CD version of the report. Addressed reviews can be marked as such using the functionality incorporated.

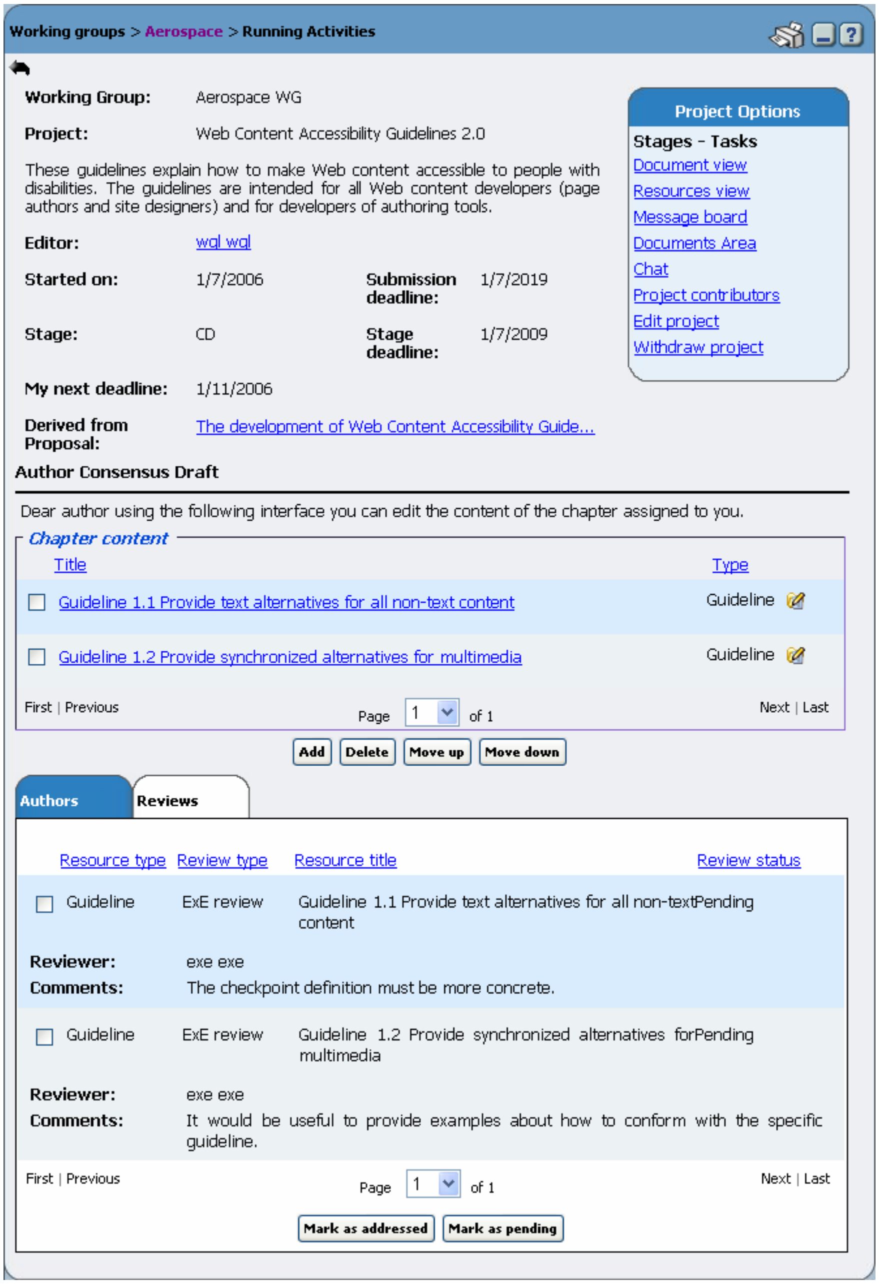


Figure 6:142: The chapter editing area

WG Leader comments

The WGL in this stage reviews the CD version of the report and provides comments (see Figure 6:143).

Figure 6:143: WG Leader comment on the CD version of the report

Approval

During this task, the NMC Leader views the CD version of the report and the comments made by WGL, and decides about the approval of the report, as shown in Figure 6:144. Approval of the report initiates the Restricted review stage of the project. On the other hand, rejection of the CD version of the report results in the non successful completion of the project.

Figure 6:144: NMC leader decision

Restricted review

The next stage of the project is Restricted review. To complete this stage, six steps need to be carried out (Figure 6:145), and namely:

- Set deadlines
- Invite IPs
- Review CD
- Rationalise comments
- Suggestions to NMC Leader
- Approval

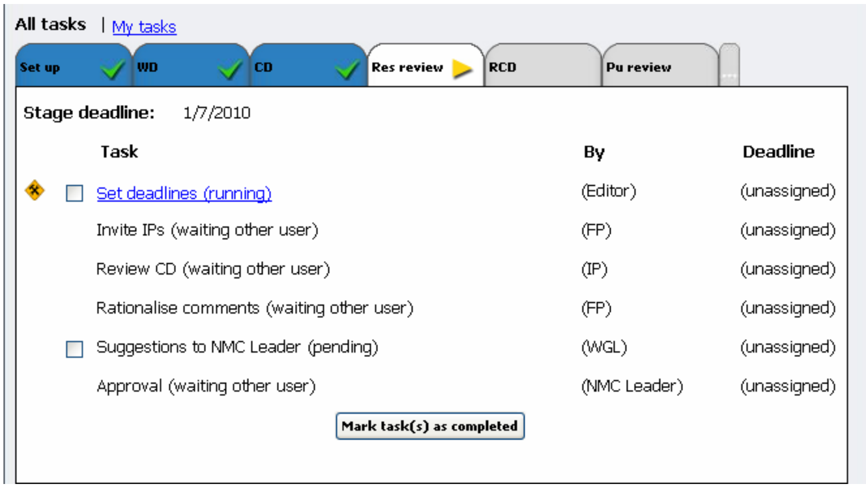


Figure 6:145: The tasks contained in the Restricted review phase

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the Restricted review stage.

Invite IPs

During this task, the FP acting as representative for a number of IPs invites the ones who are required to participate in the restricted review of the project, as shown in Figure 6:146. An invitation notification is submitted to all invited members. Upon acceptance of this invitation, the IPs can access the proposal and the FP is notified about their decision.

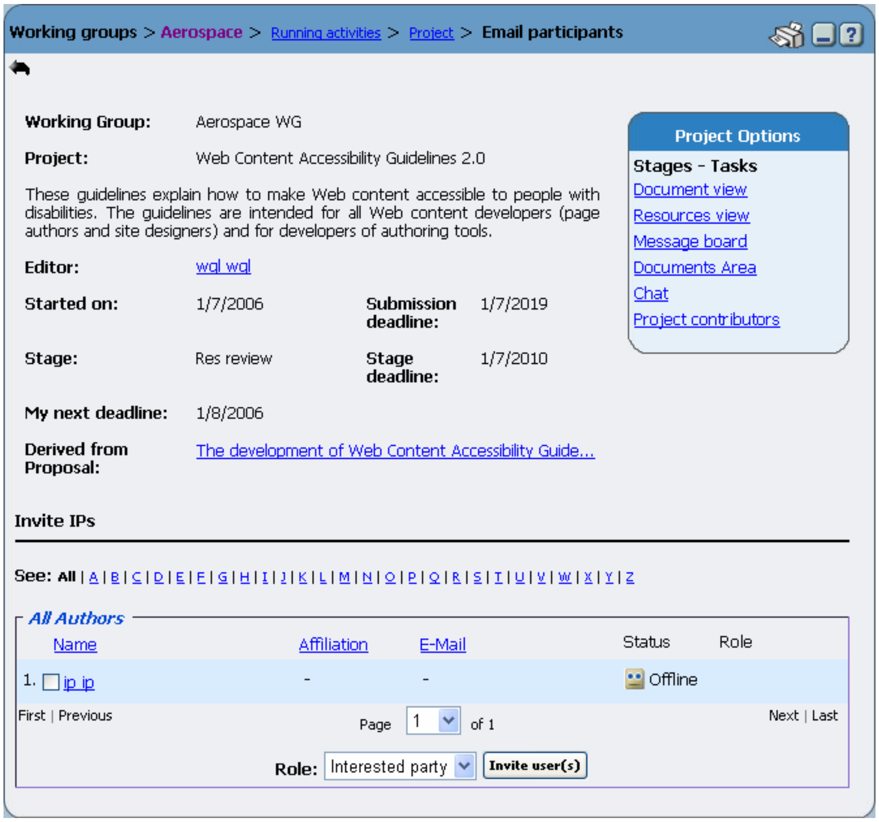


Figure 6:146: Invite the IPs to participate in the Restricted review

Review CD

In the context of this task, the IPs invited during the previous task review the CD version report providing their comments. The reviewing process is carried out in the same way already described in the case of WGL comments, ExE comments, etc.

Rationalise comments

The FP responsible for inviting IPs has the additional responsibility to rationalize the comments submitted during the CD report review. This tasks aims at providing WGL with feedback about the potential impact of the report to the target market. FP access the project content along with the IP comments and submits the comments rationalisation report, as shown in Figure 6:147.

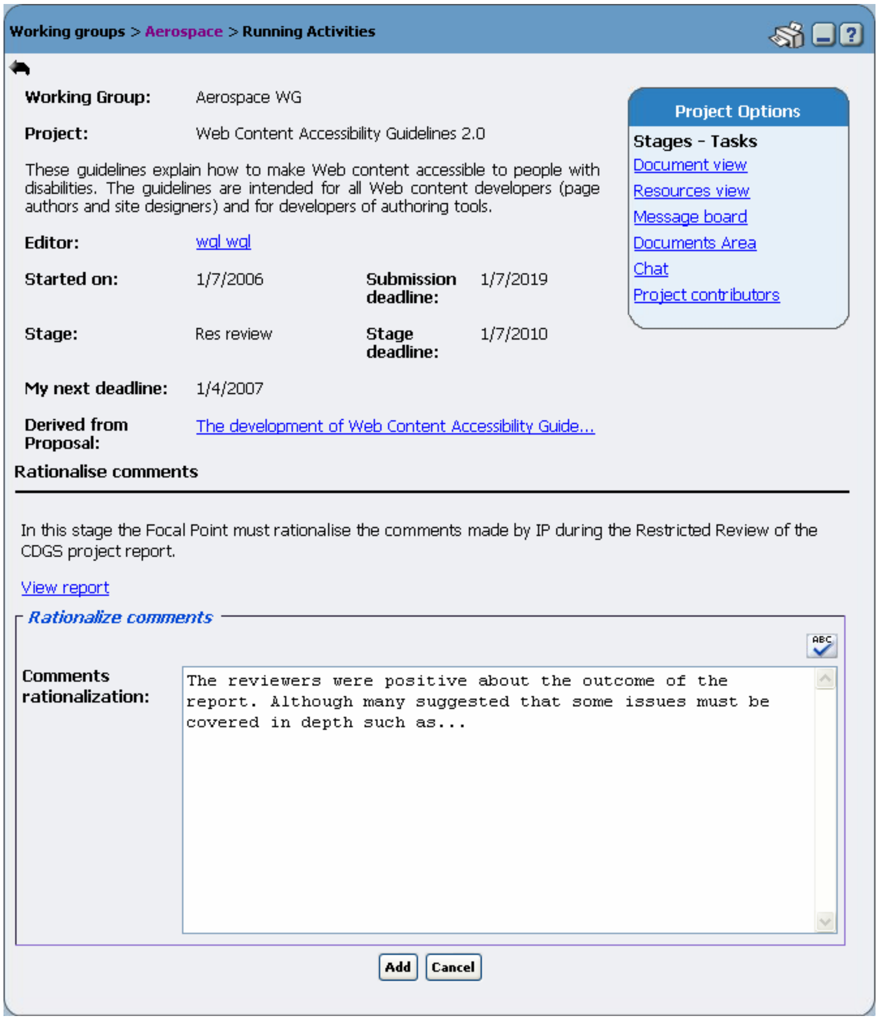


Figure 6:147: Rationalise comments

Suggestions to NMC Leader

The responsibility of WGL during this task is to view the report submitted by FP and provide suggestions to NMC Leader regarding the approval of the CD report. The interface provided to WGL displays the report submitted by FP and provides an area were WGL can fill in the suggestions to be submitted to the NMC Leader, as shown in Figure 6:148.

Figure 6:148: Suggestions to NMC Leader regarding report acceptance

Approval

NMC Leader has the responsibility to decide about the report approval, taking into account the suggestions made by WGL. The interface provided to NMC Leader to carry out this task (see Figure 6:149) displays the suggestions submitted by the WGL followed by the appropriate functionality for the decision. NMC Leader provides the rationale of the decision and proceeds with the acceptance or rejection of the report.

Figure 6:149: NMC Leader approval

Revised Consensus Draft (RCD)

The next stage of the project is RCD. To complete this stage, four steps need to be carried out (Figure 6:150), and namely:

- Set deadlines
- Author RCD
- WG Leader comments
- Approval

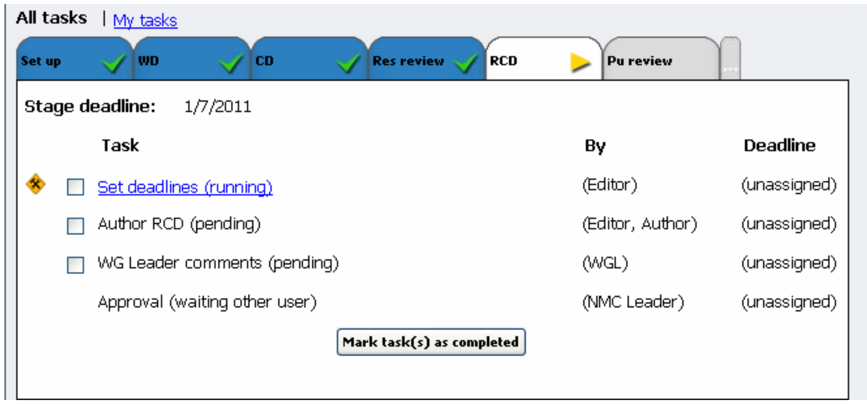


Figure 6:150: The tasks contained in the RCD stage

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the RCD stage .

Author RCD

This stage entails the authoring of the revised version of the project report. The CD version of the report was the result of the incorporation of comments submitted by ExE, GSEs and the WGL. On the other hand, the authoring of the RCD version of the report aims at the incorporation of comments submitted during the restricted review. This process is carried out in the same way as the drafting of the CD version of the report. The authors of the report access the comments made through the authoring section of a chapter and address them, altering the resources contained in each chapter accordingly.

WG Leader comments

In the context of this task, WGL provides suggestions to NMC Leader regarding the RCD report approval, based on knowledge of the authoring process and the revisions made to the report for the generation of the CD and RCD versions. This task is accomplished by filling in the comments to be submitted in the form displayed in Figure 6:151.

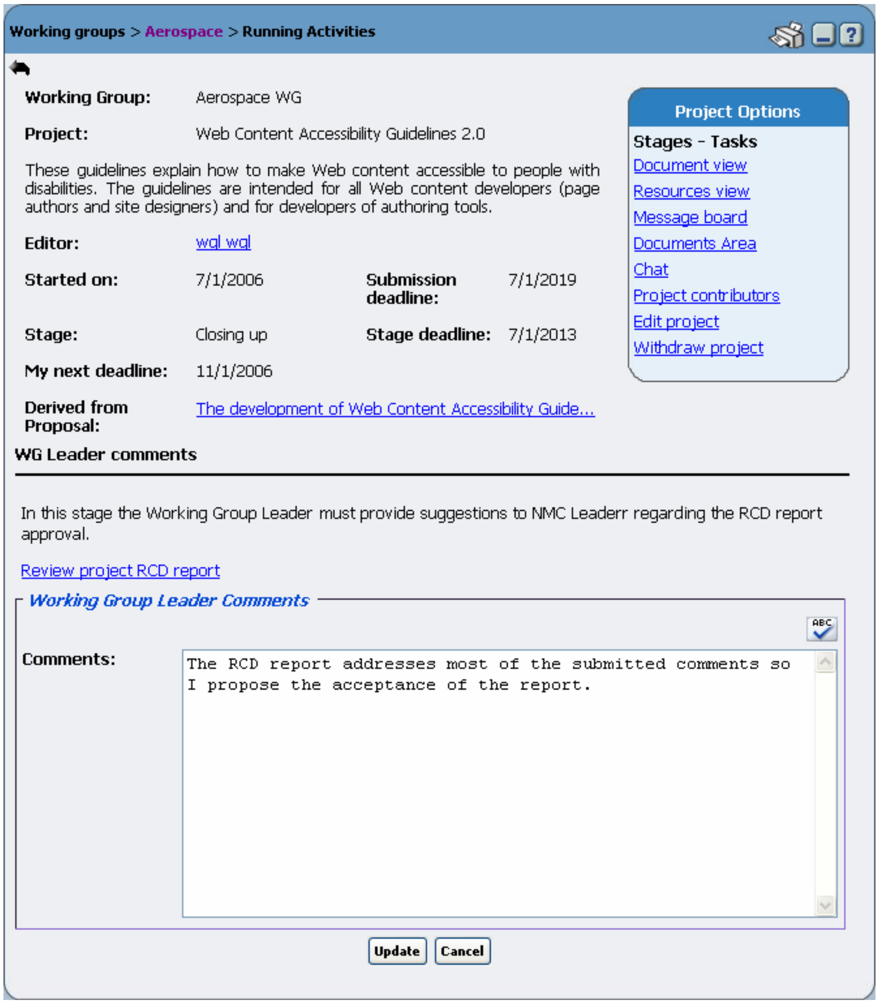


Figure 6:151: WG Leader suggestions regarding RCD report approval

Approval

NMC Leader has the responsibility to decide about the report approval, taking into account the suggestions made by WGL. The interface provided to NMC Leader to carry out this task (see Figure 6:152) displays the suggestions submitted by the WGL followed by the appropriate functionality for the decision. NMC Leader provides the rationale of the decision and proceeds with the acceptance or rejection of the report.

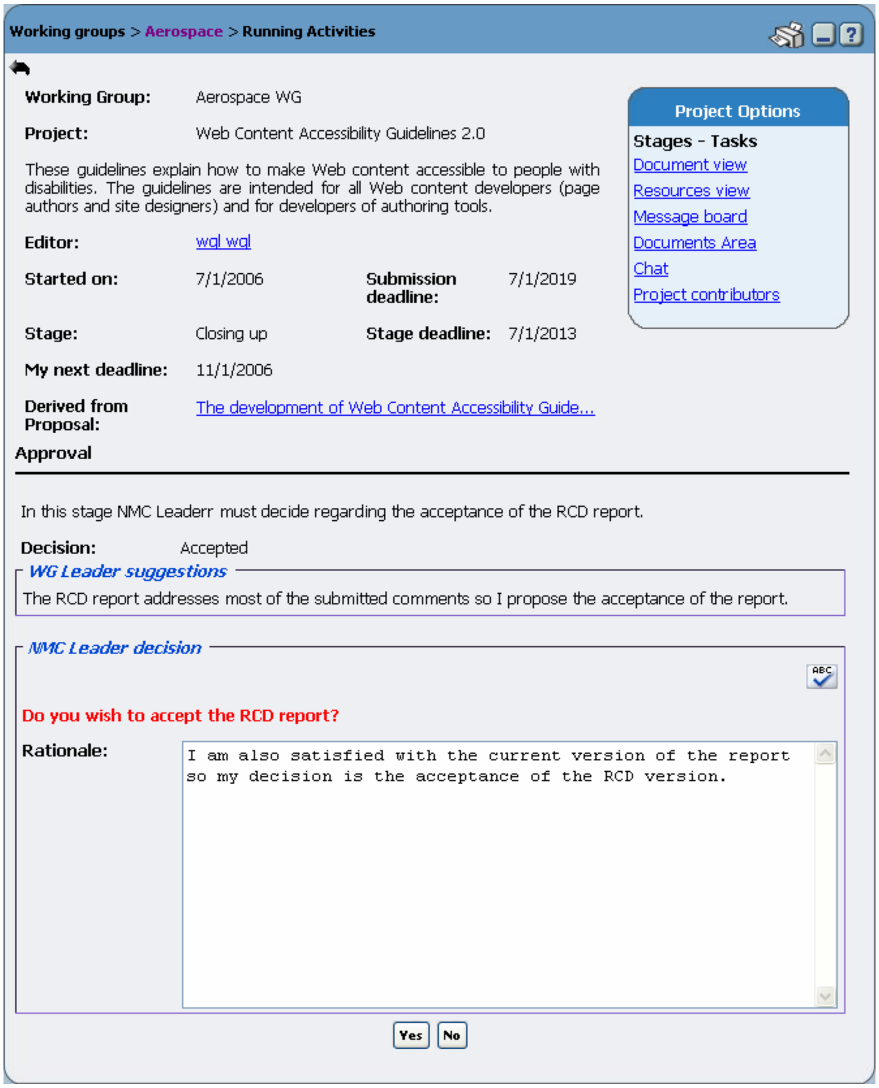


Figure 6:152: NMC Leader approval on RCD report

Public review

The next stage of the project is RCD. To complete this stage, four steps need to be carried out (Figure 6:153), and namely:

- Set deadlines
- Publish report for public review
- Get informed about user comments
- Prepare final report

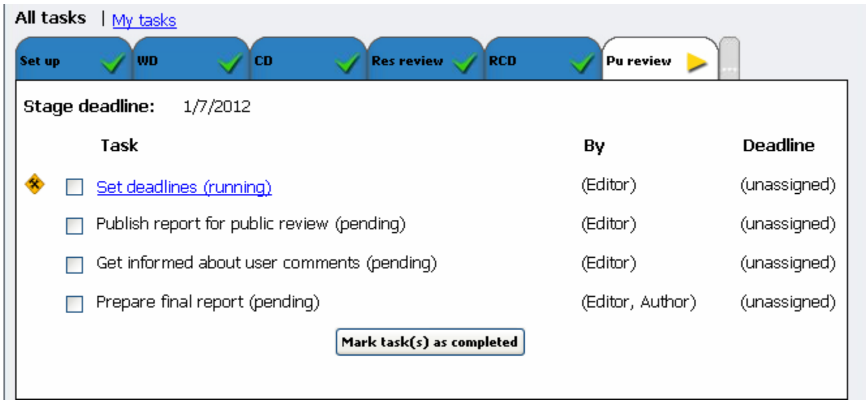


Figure 6:153: The tasks contained in the Public review stage

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the Public review

Publish report for public review

The final review phase that a report undergoes is the public review, aiming at gathering comments from the target user population of the report. The reviewers participating in this process are knowledge consumers and portal visitors. In the context of this task, the WGL specifies the time period that the RCD version of the report will be publicly available, as shown in Figure 6:154. The report is withdrawn from the reviewing area by the expiration of the reviewing period or by the completion of the public review task.

Figure 6:154: Publish report for public review

Get informed about user comments

This task aims at informing the editor and authors of the proposal about the comments submitted by knowledge consumers and site visitors in the context of the public review phase. Such comments are submitted on the entire document and not on specific chapters of the report, and therefore the interface displaying them presents the total amount of submitted comments in paging mode, as shown in Figure 6:155.

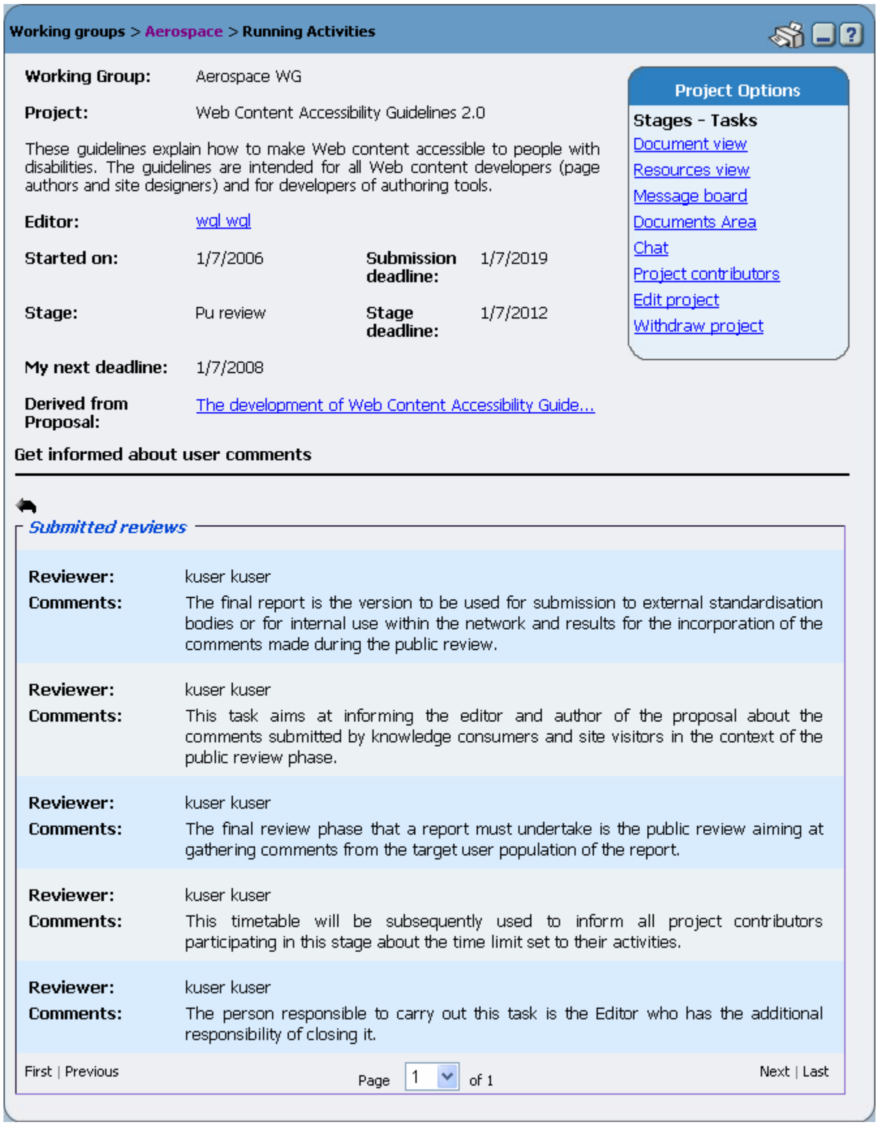


Figure 6:155: The comments submitted during the public review

Prepare final report

The final report is the version to be used for submission to external standardisation bodies or for internal use within the network, resulting from the incorporation of the comments made during the public review. The authoring of this report is also accomplished using the process already described in various phases of the project such as the WD or CD drafting.

Closing up

The final stage of the project is Closing up. To complete this stage, four steps need to be carried out (Figure 6:156), and namely:

- Set deadlines
- Final decision
- Get informed about final decision
- Publish final report

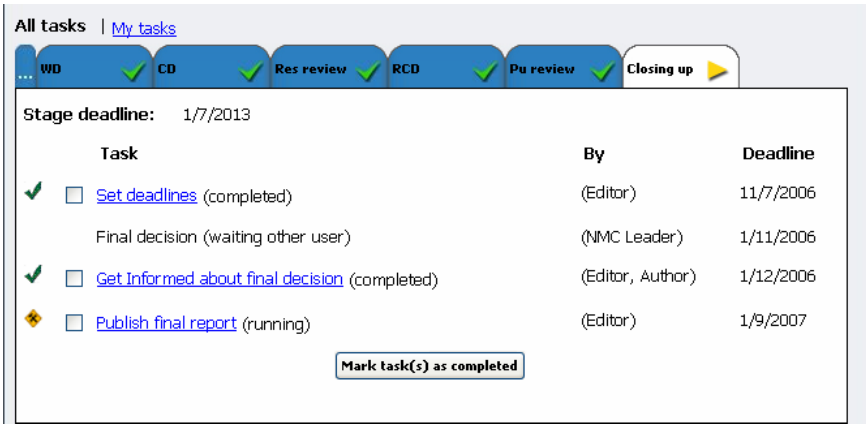


Figure 6:156: The tasks foreseen for the Closing up stage

Set deadlines

The objective of this task is to assign deadlines to the tasks contained in the Closing up stage.

Final decision

In this stage, the NMC Leader decides about the final approval of the project report, as shown in Figure 6:157.

Figure 6:157: Decide about the final acceptance of the CDGS report

Get informed about final decision

In this stage the Editor, Authors and WGL are informed about the final approval of the project report under development, as shown in Figure 6:158.

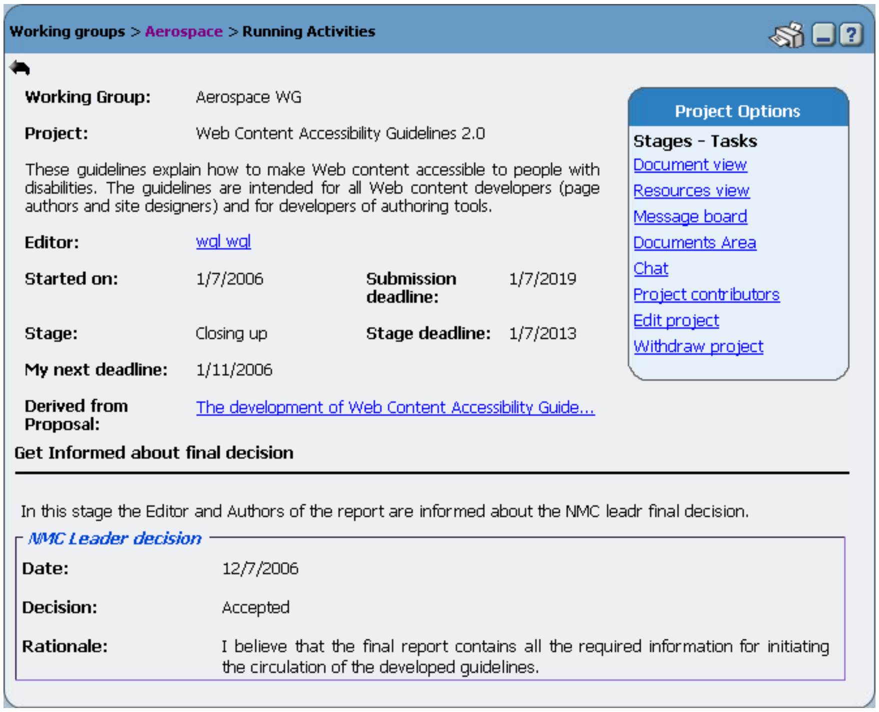


Figure 6:158: Get informed about the final decision

Publish final report

A published report can be accessed by knowledge consumers through the digital Library and upon subscription to the appropriate dataset. The Editor of the project report is provided with the means to decide whether the report should be published in the digital library or not. The resource type assigned to the report during publication varies according to the selected project outcome. The publication of the report is carried out with the aid of the resource insertion wizard. The information contained in the insertion interfaces are either filled in by default using the details extracted from the project, such as contributors, content, publication, date, etc., or filled in by the project Editor as shown in Figure 6:159.

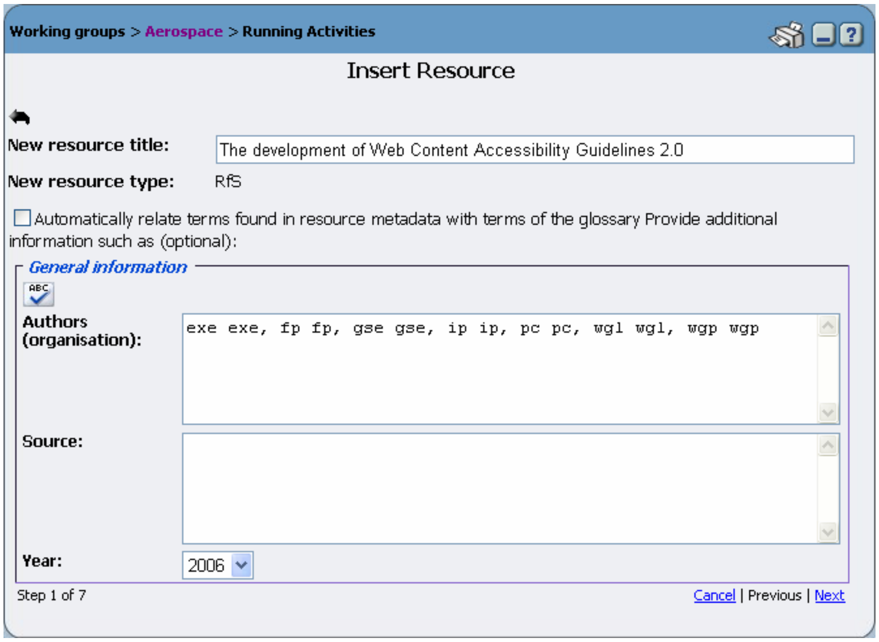


Figure 6:159: Publish final report

6.2.6 Knowledge Administrators

6.2.6.1 Subscriptions

The subscriptions functionality provides the means for administrating all the requests of subscription to datasets by knowledge consumers, as shown in Figure 6:160.

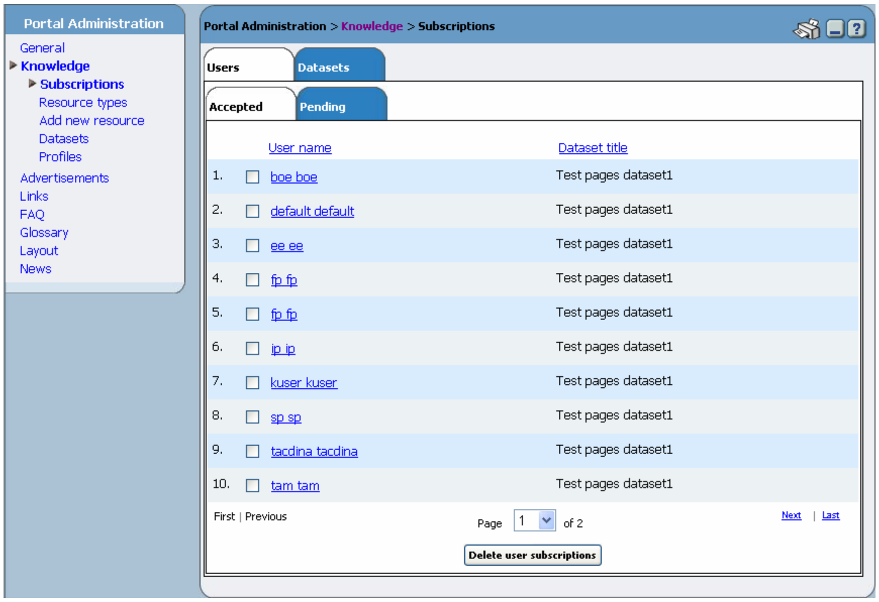


Figure 6:160: The subscriptions administration facility

This module contains in two main areas:

- **User subscriptions:** Contains the subscriptions requests organised according to the user requesting the subscription and can be further subdivided into:
    - **Accepted subscriptions:** Represents the accepted user subscriptions. The actions performed through this area are:
        - **Cancel existing subscriptions:** User looses access to the contents of the specific dataset.
    - **Pending subscriptions:** Represents the pending user subscription requests. The actions performed through this area are:
        - **Accept subscription request:** User gains access to the content of the specific dataset.
        - **Reject subscription requests:** The request for subscription to the specific dataset is rejected.
- **Datasets subscriptions:** Contains the subscriptions organised according to the datasets for which requests have been submitted, and can be further subdivided to:
    - **Accepted subscriptions:** Displays all the available datasets and the number of accepted user subscriptions.
    - **Pending subscriptions:** Displays all the available datasets and the number of pending subscription requests.

From the aforementioned areas administrators has the additional option to perform:

- **Massive subscriptions to knowledge datasets:** Add users to a dataset without prior request
- **Massive cancellations of subscriptions:** Cancel already existing subscription to datasets.

6.2.6.2 Resource types

The resource types' area provides the means for administrating the types of resources that can be contained in the digital library. Therefore, it is the main customisation mechanism of the digital library. The resource types interface (see Figure 6:161) is divided into two main areas: the created and predefined types.

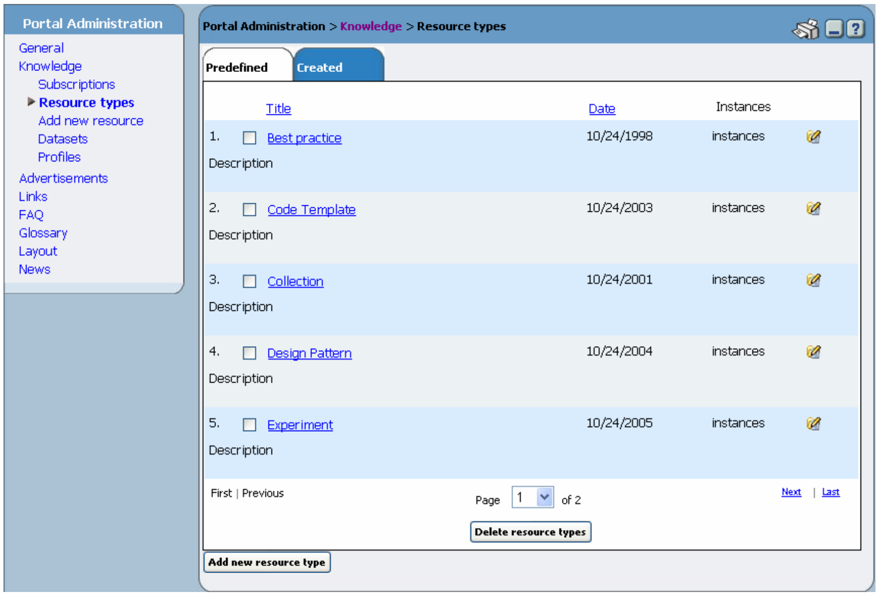


Figure 6:161: The resource types' administration facility

The predefined area displays the resource types that are built-in in the system. On the other hand, the created resource types contain the types created by the knowledge administrators. From each of the aforementioned area, administrators can perform the following actions:

- **Delete resource type:** By deleting a resource type, all resources of this type are removed from the digital library and this type is no longer available for browsing.
- **Insert resource type:** The insertion of a new resource type entails the process of connecting the resource type with a number of information categories and information fields, as shown in Figure 6:162:. The interface provided for inserting a new resource type requires as first step the provision of a type name. This interface also provides a list of the information categories available. Each information category contains a list of information fields, accessed through the expand icon. Information categories and fields are also accompanied by a text field where the alternative name to be used during the presentation of resources can be entered. To insert a new resource type, the information categories to be provided by the resource and the alternative name assigned to each category for presentation must be specified. All the information categories are optional, except for the general info category which is mandatory. For each selected information category, the information fields to be contained and their alternative name for presentation are also specified. Upon completion of the

aforementioned steps, the new resource type can be inserted and resources of the type specified will be available through all the resource browsing facilities of the portal.

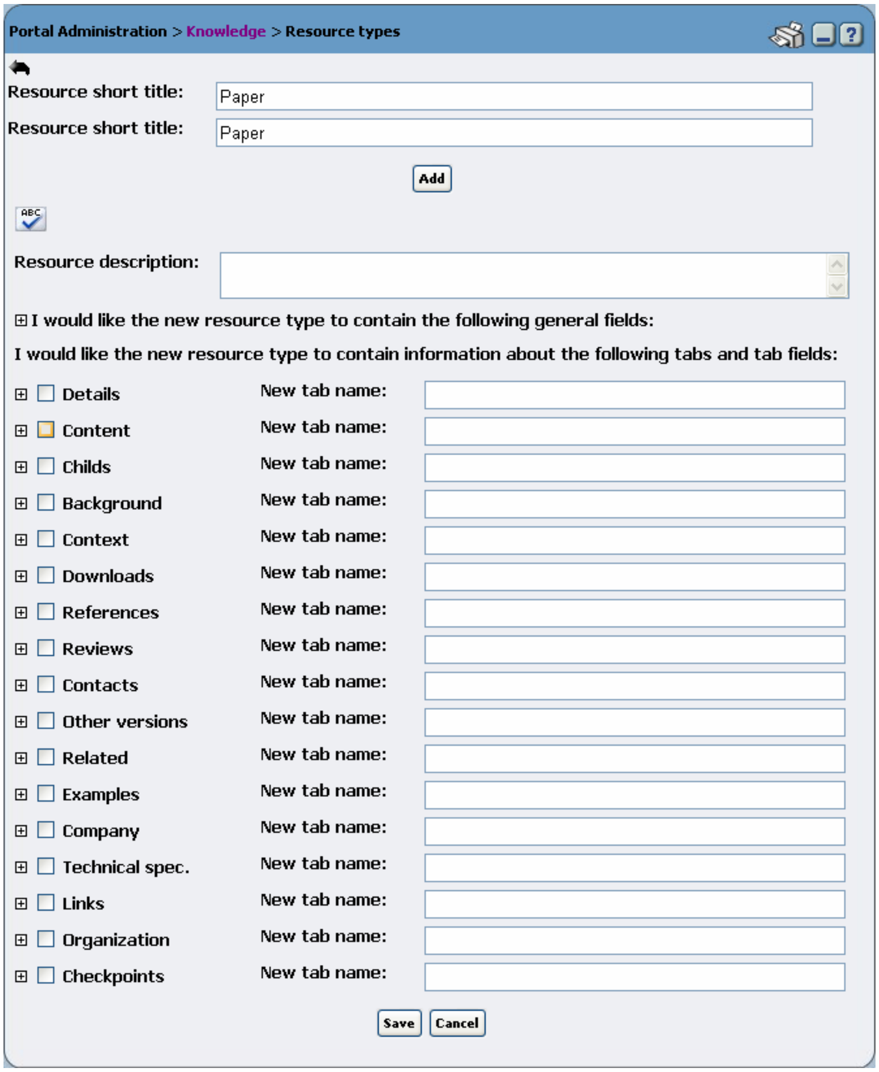


Figure 6:162: Insertion of a new resource type

- **Edit resource type:** The editing of a resource type entails altering the connections made among the type and a number of information categories and information fields, as shown in Figure 6:163. By completing this process, all the interfaces for inserting, editing and presenting resources of the specific type are altered according to the updated selection of information categories and fields.

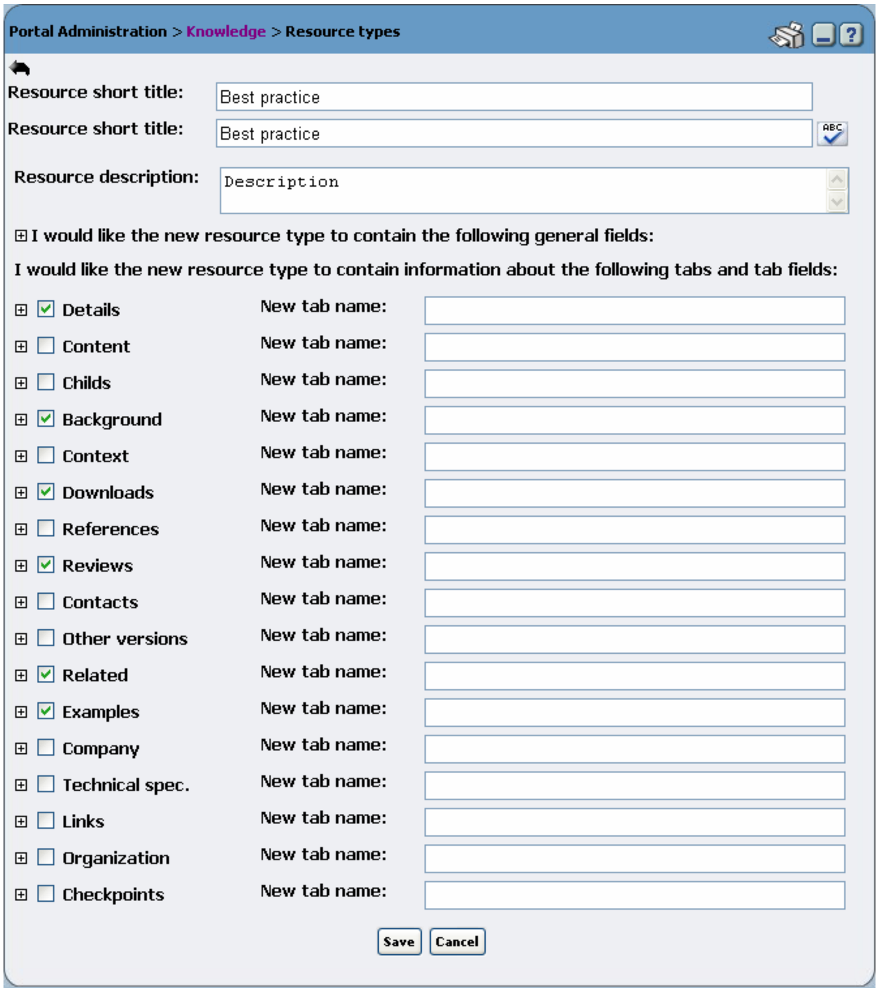


Figure 6:163: Edit resource type

6.2.6.3 Datasets

Datasets are the areas were the administration of the knowledge collections provided to knowledge consumers for registration is performed (see Figure 6:164). This is the second customisation mechanism of the digital library, which together with the resource types' administration can modify the contents provided to knowledge consumers.

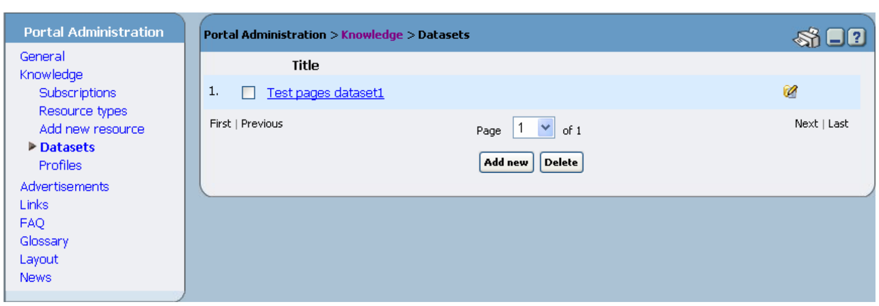


Figure 6:164: The datasets administration facility

Through this area, the following actions can be performed:

- **Add new dataset:** The process of creating a dataset is accomplished by filling a simple form, as shown Figure 6:165.

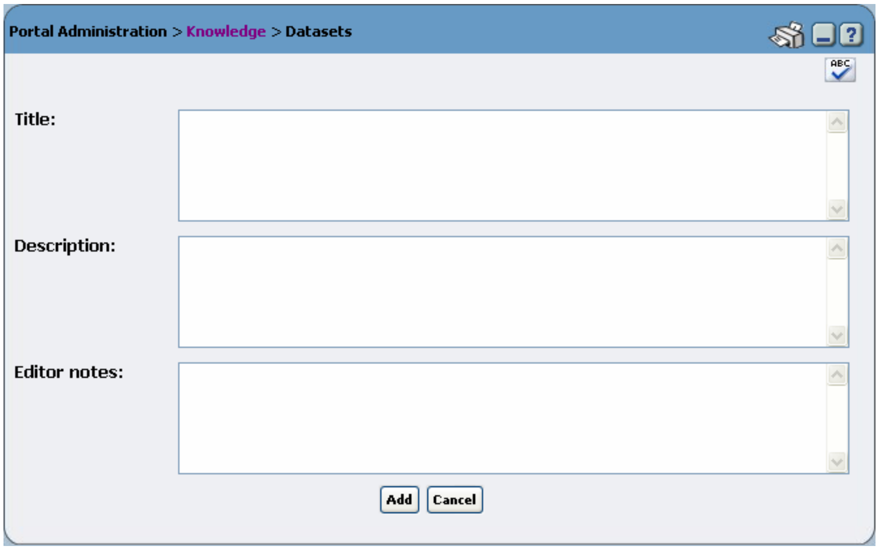


Figure 6:165: The interface used to create a new dataset

Upon creation of a dataset, resources can be added to it through all the functions that enrich the digital library contents, such as the publish document task of the proposal or project and the "add new resource" function provided to knowledge administrators.

- **Delete dataset:** By deleting a dataset, all the contained resources are removed from the digital library and all user subscriptions to this dataset are cancelled.
- **Edit dataset**: The function of editing a dataset entails the process of altering its details visible to knowledge consumers.

6.2.6.4 Dataset Contents

The resources contained in a dataset can be viewed by selecting the dataset title from the aforementioned interface. The resulting interface provides a tab –based representation of the resource types. Each tab displays the resources available for the specific type. The actions that knowledge administrators can perform with the help of this interface are:

- **Add new resource(s):** As already stated, each resource type is connected with a number of information categories and information fields. This information about a resource type is used to generate the interface required to insert a new resource. The insert resource interface shown in Figure 6:166 requires the provision of a title and type of the resource in order to begin the process of insertion. Using the selected type, the insertion interface requests the information categories and information fields of the resource type and adapts the generic insertion interface to the resource type. The resulting interface is a wizard like insertion mechanism, where each information category is displayed as a step of the wizard. The steps needed to complete an insertion are connected with the number of information categories assigned to the resource type. Each step of the wizard is additionally altered according to the fields selected from each information category and the alternative names provided to each field. The task of inserting a resource requires completing a number of steps. In each step, the user is required to insert the additional information needed and move to the next one. The navigation between steps is accomplished using the navigation functionality incorporated in the insertion interface, and does not affect the inserted information of each step. Therefore, the user can go back to a previous step and alter the details inserted. The final step of each insertion displays a confirmation message and prompts the user to save the resource, thus completing the insertion.

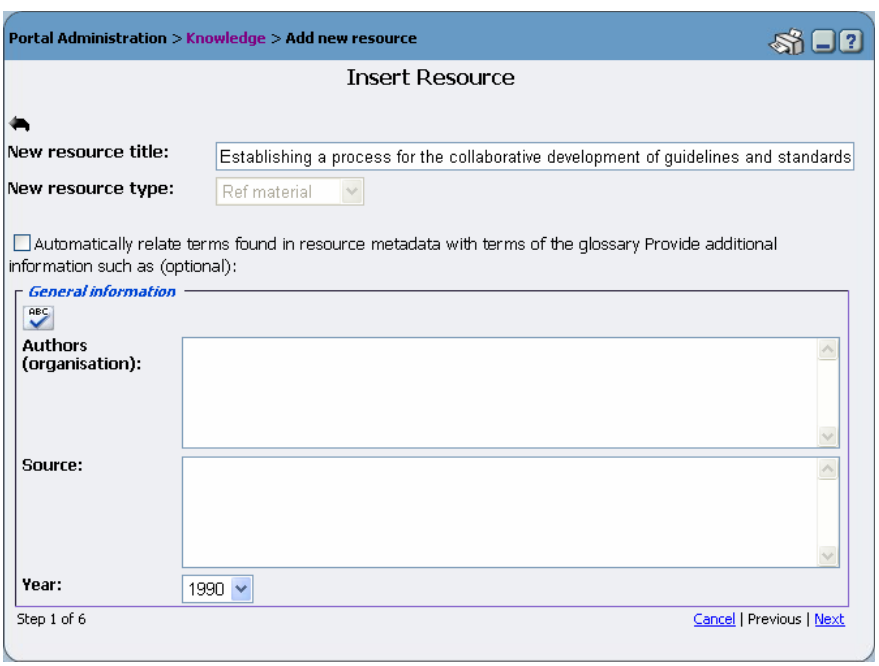


Figure 6:166: The insert resource interface

- **Delete resource(s):** The task of deleting a resource entails the process of selecting the resources to be deleted from the dataset content and selecting the delete resource function.
- **Edit resource:** The process of editing a resource is complementary to the insertion of the resource. Therefore, the interface provided is also a wizard-like interface, where each information category connected to the resource type is represented through a step, and each information field of a category as a field of the step (Figure 6:167). The user has only to edit the already inserted information in each information category and save the resource. With the completion of this process, the new altered version of the specific resource becomes immediately available to dataset subscribed users.

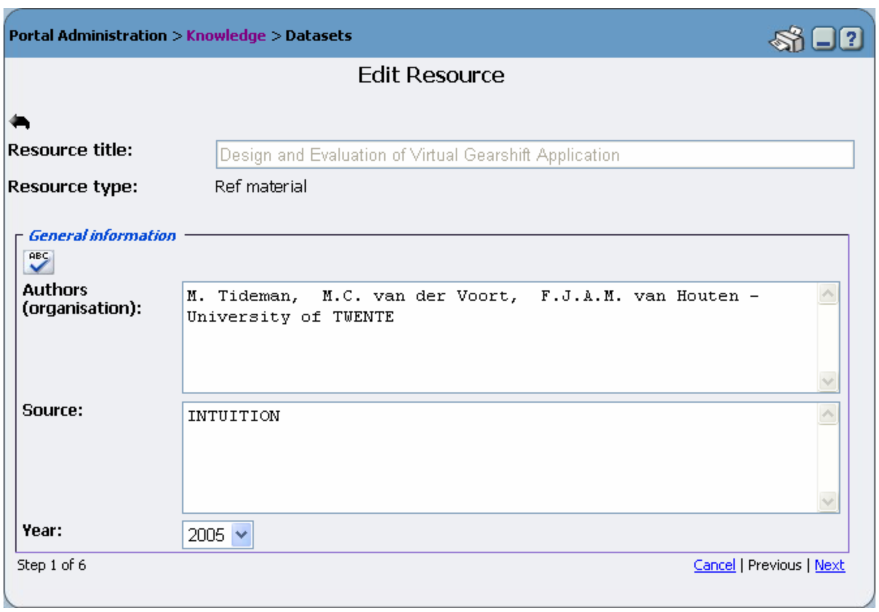


Figure 6:167: Edit resource

6.2.6.5 Profiles

The profiles section is used by knowledge administrators to administer the predefined profiles made available to knowledge consumers for results filtering, as shown in Figure 6:168. These profiles are not editable by knowledge consumers and can only be personalised to address the specific need of an individual, as described in section 6.2.3.10.

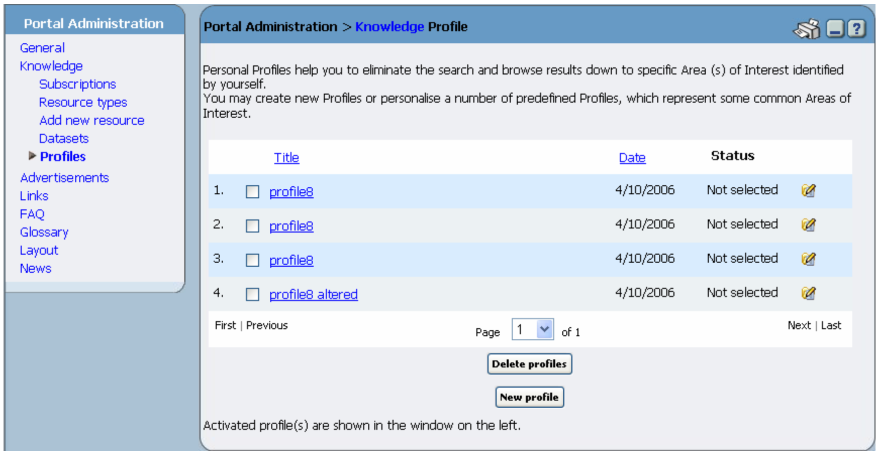


Figure 6:168: The profiles administration facility

Through this interface the following actions can be performed:

Add new profile: A profile added by the knowledge administrator is instantly available to knowledge consumers for use during navigation. The process of adding a profile entails connecting the profile with a number of criteria used for filtering, such as the resource types, the average rating of the results, etc., as shown in Figure 6:169.

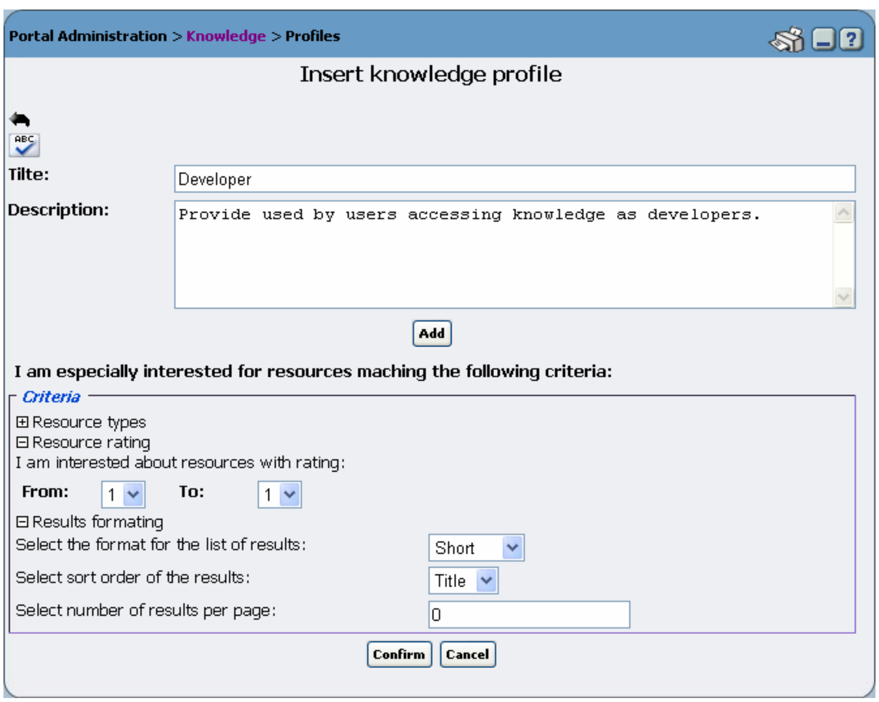


Figure 6:169: The interface used for inserting a profile

Delete profile: A deleted profile is no longer available to knowledge users for use or personalisation. Additionally, by performing this action all user selection of the profile are cancelled.

Edit profile: The process of editing a profile entails altering the connections of the specific profile to resource types and average rating of results.

6.2.7 General functionality

6.2.7.1 Printer friendly

The printer friendly functionality provides all portal users access to a printable version of a page. This function is accessed through the print button appearing in the top left corner of a content window. The selection of this function displays a new browser window that contains the content to be printed. The styles used to generate the content are also preserved in order for the content to maintain its look and feel. The overall process is presented in Figure 6:170.

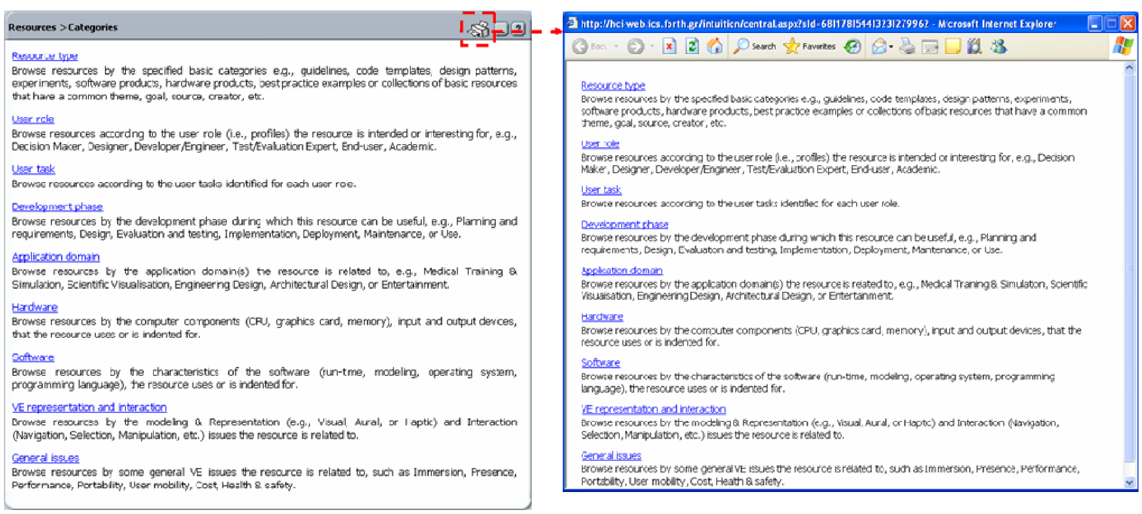


Figure 6:170: The printer friendly functionality

6.2.7.2 Spell checking

All the text insertion interfaces provided by the portal contain additional functionality for checking the spelling of the text inserted. The selection of the spell checking button displays an interface for scanning all the text entry fields. For each misspelled word, the possible alternatives are displayed. The user has only to select the alternative and press the replace button. To provide the spell checking facility, the NETSpell[25] control, which is publicly available under GNU licence, was used.

6.2.7.3 Context sensitive help

Each content window displayed by the portal contains a help button in the top right side of the window. The selection of this icon displays the help topics associated with the interface currently browsed, thus making available to users help that is specific to the functions that can be performed by the interface currently browsed, and reducing the time needed to find the requested help topic among all the available help topics.

[25] http://www.loresoft.com/Applications/NetSpell/default.aspx

7. Implementation

7.1 General architecture of the system

The architecture of a system reflects the spatial arrangement of application data and the spatio-temporal distribution of computation. The minimal spatial configuration of a Web application is the so-called two-tier architecture, which closely resembles the traditional client-server paradigm. This is different from client-server, wherein the two-tier solution clients (i.e., browsers) are thin, lightweight applications responsible only for rendering the presentation. Application logic and data reside on the server side. A more advanced configuration, called three- or multi-tier architecture, separates the application logic from data, introducing an additional distinction of responsibilities at the back-end side. The presence of one or more distinct application tiers enables the implementation of advanced architectures that integrate the traditional HTTP protocol and client-server application distribution protocols for better performance, scalability, reliability, and security (Fraternali, 1999).

The advantages of a multi-tier architecture mainly derive from the separation of the various independent parts of a system. In this respect, a multi-tier architecture offers (Intel, 2001):

- *scalability*: depending on the application requirements, the layers scale at different rates and provide developers with suitable tools for the development of each layer;
- *availability and reliability*: combined with the appropriate hardware architecture and infrastructure, multi-tier architectures can provide the means for faultless and continuous operation;
- *platform independence*: multiple layers support the development of alternative top layers for different computer platforms;

- *performance*: such architecture is location independent if combined with the appropriate hardware architecture and infrastructure;
- *security*: a multi-layer architecture can operate in an infrastructure placed between two firewalls and thus ensure the security of the sensitive information and data.

Other advantages concern the development phase, since, if the various layers of the architecture are scalable, they can be developed and tested more quickly and can be reused if necessary. Differentiation in a layer's implementation does not influence other layers. For example, the substitution of the database management system with a different one does not require any change in the implementation of the other layers.

7.2 Architecture layers description

Considering the aforementioned advantages, the development of a multilayer architecture was adopted for the Pages for VR portal. The software architecture used includes three basic layers: data access layer, application (business) layer and presentation layer, so as to take full advantage of the benefits stemming from the multiple layers, approach as shown in Figure 7:1.

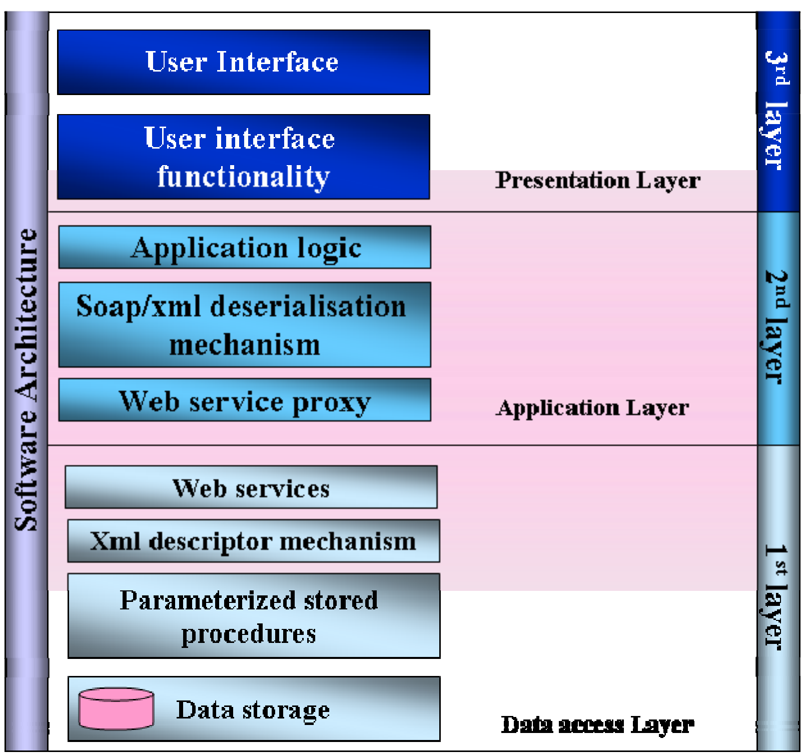


Figure 7:1: Software architecture

7.2.1 Database implementation

The ability of a web portal to support multilingualism is a fundamental principle in order to serve people with limited skills in foreign languages. Therefore, multilingualism needs to be supported both in terms of user interface and application content stored in the database. In the database layer, a design method for the separation of multilingual and non multilingual content is used. Each database table containing multilingual content is divided in two separate tables, one containing the non multilingual content and the other containing the multilingual one, as shown in Figure 7:2. In such a way, no redundant information is stored.

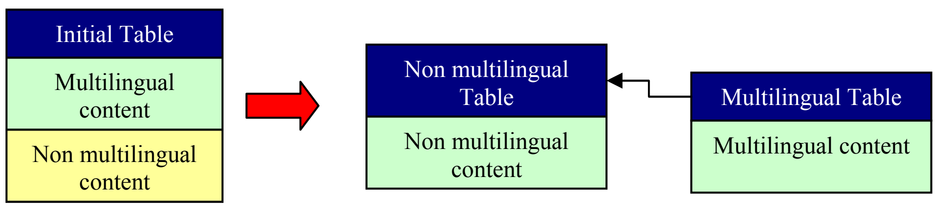


Figure 7:2: Mapping of database content to the multilingual and non multilingual equivalent

Additionally, the database implementation incorporates stored procedures for faster retrieval and insertion in the database, reducing the amount of client side processing by looking up data and maintaining key values and internal integrity. Furthermore, using stored procedures, the database server creates for each query a plan that includes all the information required to return the data effectively to the client. This plan is stored in the system's cache, so that it can be reused when needed (Dalton, 1997). Another advantage of the stored procedure is that the database server can create indexes, thus increasing the speed of interaction. An example of a stored procedure is presented in Figure 7:3.

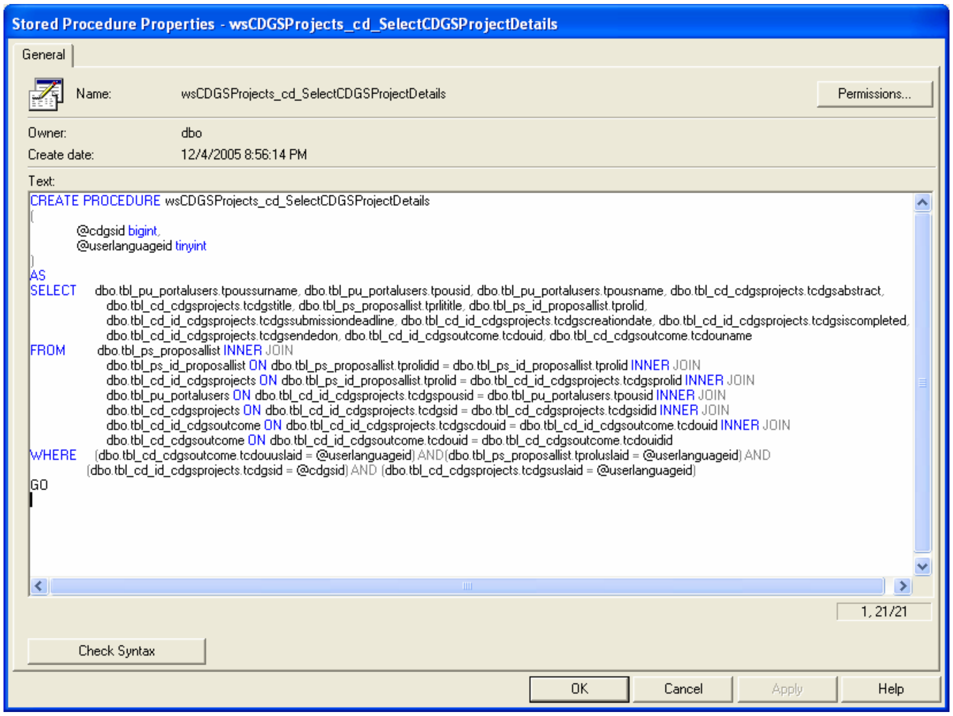


Figure 7:3: Example of a stored procedure

7.2.2 Data access Web-Services

In the data access layer, the stored procedures created in the database are accesses by web services that are subsequently available to the business logic layer. The implementation of these web services incorporates an XML query descriptor mechanism (Jorgensen, 2002) that undertakes to connect to the database management system, call the appropriate predefined query using the available query description, pass the suitable parameters and return the acquired data. This module consists of a software library that communicates with the database and several xml files containing the description of the predefined queries for various system components. As illustrated in Figure 7:4, the XML query descriptor library module accepts the request from the upper sub-layer, reads the XML query description file, and calls the predefined query. The query accesses the database and fetches the necessary data that are subsequently returned to the XML descriptor library module.

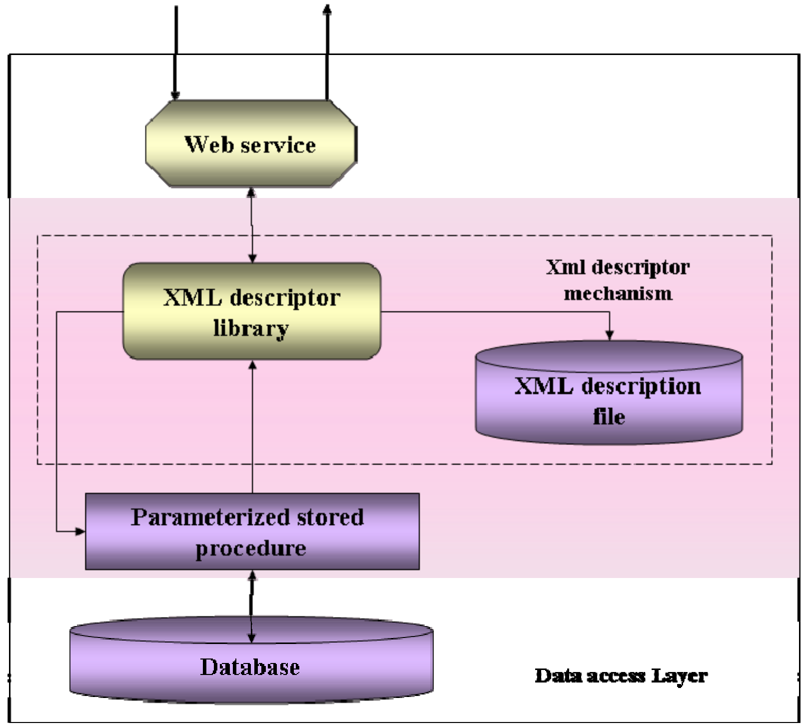


Figure 7:4: The overall process flow in the data access layer

The objective of the XML (eXtensible Markup Language) query descriptor library module is to provide a consistent mechanism for accessing the underlying sub-layers using a unique and secure way of connecting to the database. Uniqueness is achieved through the use of the same module for every access to the database while security is achieved through "on the fly" encryption and decryption of the database connection string. The security mechanism implementation is realized using the Win32® Data Protection API (DPAPI) (Microsoft, 2003c) that is inherent in the Microsoft Windows™ Operating System, ensuring that the database connection string is secured from unauthorised access. Apart from the connection string, this module requires all the appropriate information to call a specific parameterised predefined query from the database. For achieving library reusability and database independence, an XML query description file is used to retrieve such information. The main benefit of XML as a data representation language is that it makes the data easier to migrate from one computer system to another. The abstract structure of this XML file is illustrated in Figure 7:5,, and consists of the query and of parameters related information. More specifically, the XML file contains the name and the type of each query and the associated list of parameters with the necessary details (i.e., name, type, size and direction).

```xml
<?xml version="1.0" encoding="utf-8" ?>
    <wsComponentName>
        <Method Name="WebMethodName">
            <StoredProcedure>
                <Name>SPName</Name>
                <Type>SPType</Type>
            </StoredProcedure>
            <Parameter>
                <Name InternalName="ParameterName">@SPParameterName</Name>
                <Type>DataType</Type>
                <Size>DataSize</Size>
                <Direction>ParameterDirection</Direction>
            </Parameter>
        </Method>
    </wsComponentName>
```

Figure 7:5: The abstract structure of the XML descriptor file

An example of the XML description of a query is presented in Figure 7:6. This description shows that the type of the query is SELECT, while its name is "wsCDGSProjects_cd_SelectCDGSProjectDetails". It requires two input parameters with the names "cdgsid" and "userlanguageid".

```xml
<Method Name="SelectCDGSProjectDetails">
    <StoredProcedure>
        <Name>wsCDGSProjects_cd_SelectCDGSProjectDetails</Name>
        <Type>SELECT</Type>
    </StoredProcedure>
    <Parameter>
        <Name InternalName="cdgsid">@cdgsid</Name>
        <Type>bigint</Type>
        <Size>8</Size>
        <Direction>Input</Direction>
    </Parameter>
    <Parameter>
        <Name InternalName="userlanguageid">@userlanguageid</Name>
        <Type>tinyint</Type>
        <Size>1</Size>
        <Direction>Input</Direction>
    </Parameter>
</Method>
```

Figure 7:6: An XML description of a database query

Web services are responsible for providing the appropriate mechanism to transmit the data from the data access layer to the application (business) layer. Web services in general provide several advantages, since they are loosely coupled to the clients and stateless, which means that they do not require a permanent connection to the database, serving thus several clients at the same time, and allowing immediate switching between servers in a web farm (Basiura et al., 2001). Web services are also self-describing and can be automatically discovered offering great assistance to the developers, embodying an essential principle for digital library development (McCray and Gallagher, 2001). The result of a web service is a SOAP (Simple Object Access Protocol) message that contains the requested information, as shown in Figure 7:7.

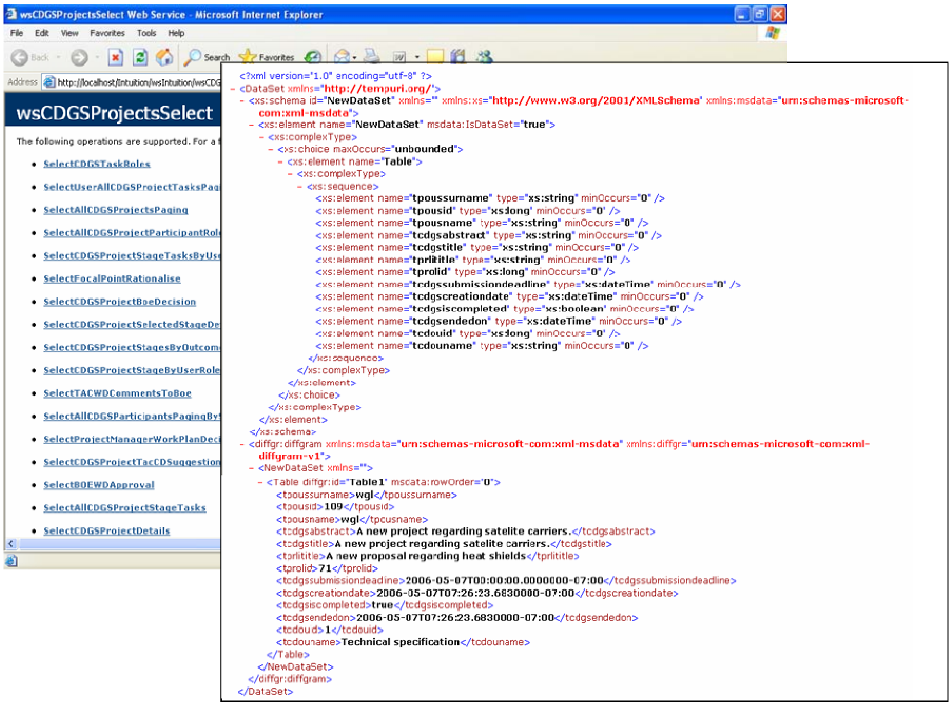


Figure 7:7: The result of a web-service invocation

7.2.3 Business logic layer

This layer incorporates the functions needed to implement the application. More specifically this layer contains classes that form a higher level ontology specification of the database schema (Figure 7:8). The aim of this layer is to transform the data received by the web services of the data access layer to instances of the ontology specification. To this purpose, special methods are used to deserialize the data received and transform them into meaningful instances of the ontology (Figure 7:9). Additionally, this layer contains functionality that is used by the interface layer to perform certain actions. This strategy is followed in order to make the development of the higher levels of the portal easier and closely coupled with the UI functionality The implementation of the business logic layer is totally independent from the implementation of specific parts of the data access layer, and allows the replacement of the data access layer without redeveloping the business layer. For example, the SQL Server database can be replaced by an Oracle database making the appropriate changes only in the XML description files.

```
public class SelectCDGSProjectDetails
{
    private System.String _tpoussurname;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tpoussurname")]
    public System.String tpoussurname
    {
        get{ return _tpoussurname;}
        set{ _tpoussurname=value;}
    }

    private System.Int64 _tpousid;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tpousid")]
    public System.Int64 tpousid
    {
        get{ return _tpousid;}
        set{ _tpousid=value;}
    }

    private System.String _tpousname;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tpousname")]
    public System.String tpousname
    {
        get{ return _tpousname;}
        set{ _tpousname=value;}
    }
    private System.String _tcdgsabstract;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tcdgsabstract")]
    public System.String tcdgsabstract
    {
        get{ return _tcdgsabstract;}
        set{ _tcdgsabstract=value;}
    }

    private System.String _tcdgstitle;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tcdgstitle")]
    public System.String tcdgstitle
    {
        get{ return _tcdgstitle;}
        set{ _tcdgstitle=value;}
    }

    private System.String _tprlititle;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tprlititle")]
    public System.String tprlititle
    {
        get { return _tprlititle;}
        set{ _tprlititle=value;}
    }

    private System.Int64 _tprolid;
    [Browsable(false),DesignerSerializationVisibility(DesignerSerializationVisibility.Hidden)]
    [XmlElement("tprolid")]
    public System.Int64 tprolid
    {
        get{ return _tprolid;}
        set{ _tprolid=value;}
    }

}
```

Figure 7:8: An example of a business logic class implementation

```
public SelectCDGSProjectDetails[] SelectCDGSProjectDetails (long cdgsid, short userlanguageid )
{
    wsCDGSProjectsSelect objWs = new wsCDGSProjectsSelect();
    DataSet myDataSet = objWs.SelectCDGSProjectDetails(cdgsid, userlanguageid );
    DataSetDeSerializer oS=new DataSetDeSerializer();
    SelectCDGSProjectDetails[] temparray = (SelectCDGSProjectDetails[])
    oS.DataSetDeSerialization( myDataSet, typeof(SelectCDGSProjectDetails[]), "SelectCDGSProjectDetails" );
    if(temparray!=null)
    {
        return temparray;
    }
    else
    {
        SelectCDGSProjectDetails[] nulltemp = new SelectCDGSProjectDetails[1];
        nulltemp[0] =  new SelectCDGSProjectDetails();
        nulltemp[0].tpoussurname = "null";
        nulltemp[0].tpousid = 0;
        nulltemp[0].tpousname = "null";
        nulltemp[0].tcdgsabstract = "null";
        nulltemp[0].tcdgstitle = "null";
        nulltemp[0].tprlititle = "null";
        nulltemp[0].tprolid = 0;
        nulltemp[0].tcdgssubmissiondeadline = new DateTime(1900,1,1);
        nulltemp[0].tcdgscreationdate = new DateTime(1900,1,1);
        nulltemp[0].tcdgsiscompleted = false;
        nulltemp[0].tcdgsendedon = new DateTime(1900,1,1);
        nulltemp[0].tcdouid = 0;
        nulltemp[0].tcdouname = "null";
        return nulltemp;
    }
}
```

Figure 7:9: An example of a business logic method implementation

7.2.4 Presentation Layer

For the interface layer an architectural approach containing only a single page is used. The term "single page" is used to define the portal structure where the content of each page requested by end users is composed by the union of the content provided by the portal template and the content of the user components that are dynamically added at runtime. In more detail, for each user page request the portal needs to perform certain actions. Initially when the user requests a page, an empty page container is loaded with no content at all. Subsequently a form container is created to host all the specific page components. The next stage is to access and select the page template among several different options available. The page template is used to provide the context and the positioning scheme. After the page template is loaded, the portal requests and loads the interface components that will be used to compose the content added to form the final page send to the client. For each component, the portal must specify the UI container that will host the particular content and the positioning of the component to the final page. With the completion of this process the content is added to the appropriate container, and the containers are added to their positions on the page. The process described above is presented graphically in Figure 7:10.

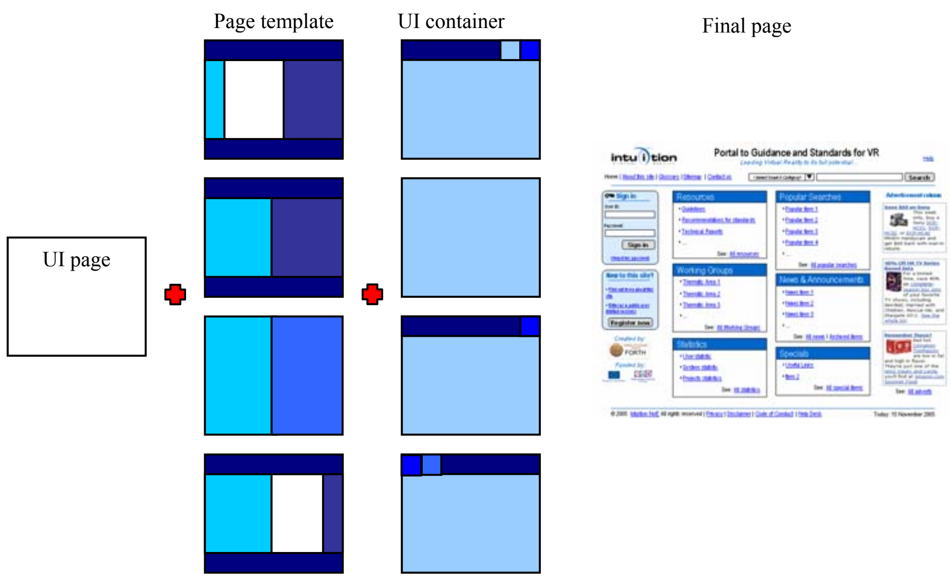


Figure 7:10: The process of creating the final interface using the "single page" approach

7.3 Technical characteristics

The various technologies used for implementing the layers of the system software architecture are presented in Figure 7:11, displaying according to the related sub-layer.

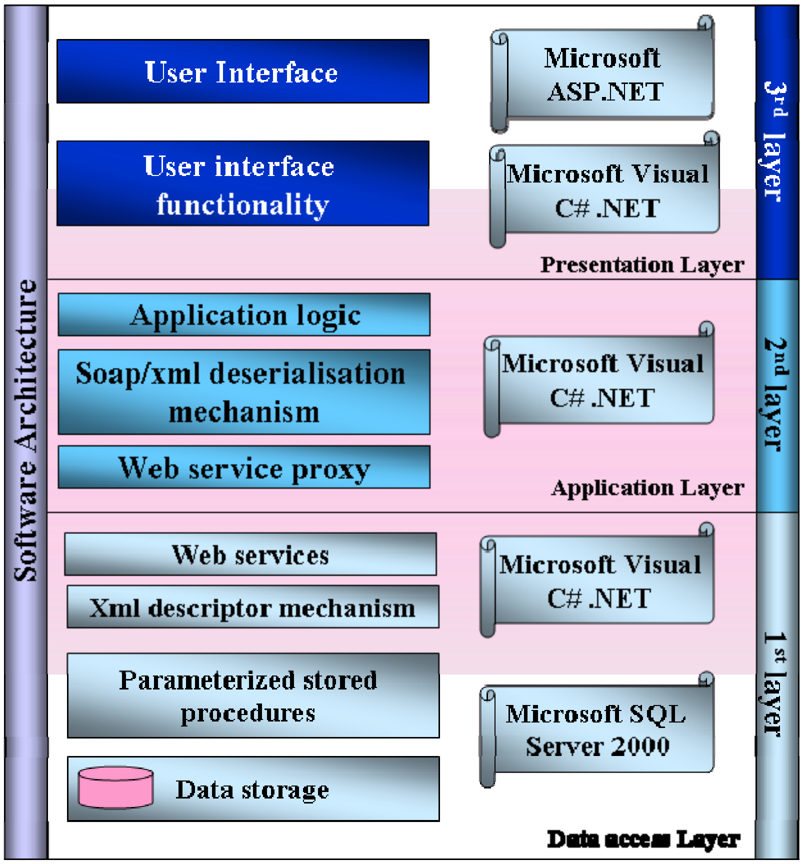


Figure 7:11: Applications layers and the technologies used

8. Discussion

This work proposes an innovative approach for implementing TFWWGs by employing portal technologies. The pilot realisation of this approach in the form of a prototype system in the domain of virtual reality has provided valuable feedback in all of the three major aspects of this work: (a) the employment of advanced portals technology for guiding and facilitating the collaborative development of guidelines and standards, (b) the integration of various information retrieval, communication and collaboration mechanisms for empowering various interested parties in exploiting the available knowledge appropriately, and (c) the use of the same platform for achieving easy and rapid dissemination of knowledge, as well as direct user support and feedback.

Regarding the first of the above aspects, our goal was largely achieved, as we were able to specify a generic process for the Collaborative Development of Guidelines and Standards (CDGS), and furthermore computerise this process in order to be operated via the web. One of the main challenges encountered in this respect was the specification of an appropriate process. The difficulties involved were: (a) the need to be generic enough and adaptable in order to ensure applicability into various application domains, (b) the need to be solid and compliant with the processes followed by a number of standardisation bodies, (c) the need to be easily operated also by people with little experience in the field of guidance and standards development, and (d) the necessity to be configurable and capable of producing a wide range of documents. Additionally the computerisation of this process was itself a major challenge. The difficulties involved included: (a) a wide range of user roles with different goals and tasks in the context of development activities had to be supported, often in combination, leading to an increased complexity of functionality and user interface, (b) the development of a mechanism for implementing the various sequential and conditional stages and tasks involved in the CDGS process, and (c) the design of an appropriate mechanism for collaborative document editing and reviewing as this incorporates various issues of privacy, authorship and intellectual property rights, coordination of read and write rights. Overall, regarding the way that the process was computerised, a potential drawback is the lack of mechanisms that track the changes made by authors in the context of proposal or project authoring especially in cases were a large number of authors is involved. Additionally another aspect that must be further considered is the check in - check out mechanism used for blocking access to chapter currently edited by other users due to the limitations that arise in the context of network-based environments.

The second of the above aspects was also considered successful, as we managed to provide a wide range of services for knowledge retrieval, such as search and browse facilities, user profiles for results filtering, as well as mechanisms for maintaining personal collections of knowledge, social navigation and community based communication. One of the main challenges encountered was the differentiation of the process of knowledge retrieval to the development one through the provision of different functionality and appearance. The difficulties involved were: (a) the development of role based layout facilities and (b) the provision of mechanisms for role layout switching for the case of knowledge developers were the role of developer and consumer may coexist. Additionally another major challenge was the design and development of the knowledge base of the system so that the process could be applied in various application domains. The main difficulties involved were: (a) the development of a knowledge base that can be extended to support new resource types and (b) the provision of a mechanism that enables the translation of process outcomes to elegant, formalised, and usable publications. Overall regarding the use of knowledge as potential drawbacks can be considered the lack of mechanisms that automatically create inter-relations among relevant publications for increasing the retrieval efficiency. Additionally the lack of mechanism for personalising (i.e., cloning) resources may reduce the usefulness of the knowledge retrieved mainly due to the fact that usually the applicability of design guidelines varies according to the application domain.

Finally, the third aspect was also satisfying, as we managed to incorporate several mechanisms available to web-surfers and visitors of the portal that aim to raise the awareness of these users regarding the work conducted on guidelines and standards. More specifically a number of alternative ways for accessing information regarding the available publications were provided accompanied with facilities such as links, advertisements, frequently asked questions etc.

The issues presented above provided enough feedback to justify our hypothesis that portal technologies can be used in order to facilitate most of the tasks involved in the development of guidelines and standards and also presented some initial clues about additional amendments to the proposed solution in order to enhance its efficiency.

9. Summary & Future work

The main objective of this thesis has been the design and development of a novel approach for supporting collaborative development and use of ergonomic knowledge, such as guidelines and standards, aiming at overcoming the limitations that arise from the way that this knowledge is traditionally handled by TFWWG. More specifically, a thorough review of currently published literature was conducted in order to acquire information about guidelines, standards and tools facilitating their development and use. Moreover, the knowledge development processes followed by a number of international and established bodies were reviewed in order to derive the CDGS, which is a generic approach for the systematic development and maintenance of guidelines and standards that can be easily altered to address the standardisation activities of any kind of body. In order for this process to be adopted by INTUITION the roles involved were mapped to the particular network organisational structure. Further to the above, the proposed process was implemented into the Pages for VR tool, an advanced web portal facilitating the development of knowledge by various groups of experts, as well the practical use of knowledge stemming by these activities by knowledge consumers. The proposed solution focused at providing a smooth integration of several well-established and reliable mechanisms, such as search and browse facilities, communication and collaboration mechanisms, project administration facilities, and digital libraries. The design of the system was conducted following a user-centred design approach that focuses specifically on making systems usable for their users through the involvement of potential users during the design of the system. Several data collection techniques were employed for the collections of requirements, the specification of users roles and tasks, and ultimately for the user interface design of the portal to serve the aforementioned requirements. The implementation of the tool was conducted with the use of novel approaches for the development of web applications elaborating techniques such as the multi-tier architecture, web services, single page model with dynamic content rendering and multilingualism of interface and application content.

Finally, in order to evaluate the prototype tool, identify possible shortcomings, and provide suggestions for potential improvements, expert-based and user-based evaluation has been planned as part of our future steps. This evaluation aims at offering valuable insight into the functional and the interaction characteristics of the system and confirming the hypothesis that there is an actual need and demand for computerised tools for developing and working with guidelines and standards.

Concerning additional enhancements of the existing mechanisms, several advanced and intelligent techniques could be applied to improve the effectiveness and efficiency of the system. For instance, process customisation can be of particular importance for supporting the integration of the system in various contexts. More specifically, during customisation the stages and tasks of the new process can be selected for supporting the collaborative development of new types of documents. This is already partially supported by the system underling infrastructures, making easier the integration of this feature in future enhancements of the system.

On the other hand, the strict version of the CDGS process incorporates additional steps for supporting the development of standards. The incorporation of these steps by the proposed portal structure can enable the development of a wider range of documents.

Furthermore, semi-automatic classification of the knowledge stored in the system's database could be investigated and implemented, based on various existing cross-referencing techniques for ergonomic resources, e.g., (Goffinet and Noirhomme-Fraiture, 1999). This scheme would help the Originators of proposals, Editors of project reports and generally the knowledge administrators in the task of extending the knowledge base of the system, by (semi-)automating the process of establishing the relation of a new resource to the existing ones, and of recognising the dependencies between such a resource and the defined classification categories.

The support of dynamic adaptation of the system infrastructure to the presentation needs of various mobile devices such as PDAs and cell phones would exploit the full potential of the system, enabling development stakeholders to have seamless access to the system even when they are not in their original working environment.

At last, but not least, the provision of enhanced accessibility features supporting user profile adaptation of the knowledge consumer's site can support the exploitation of ergonomic knowledge by users with disabilities. Towards this direction several techniques can be employed, including the provision of facilities for the transformation of a digital library's content into interactive audio form for supporting non-visual interaction (Mourouzis et al, 2006).

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