Using Knowledge Networks to support Innovation

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e) Result

Figure 90 - Various types of Knowledge Objects within the network knowledge base

The result of the initialization of various types of knowledge objects achieves the required holistic approach to knowledge. This is illustrated in Figure 90 with an example of a content listing that includes a blog entry (explicit knowledge) (see number 1 in Figure 90), a document (explicit knowledge) (number 2 in Figure 90), a biography (pointer to tacit knowledge source) (number 3 in Figure 90) and a story (explicit knowledge) (number 4 in Figure 90).

The elements of the Knowledge Network Architecture that have been illustrated thus far constitutes the basis of a Knowledge Network. By allowing the Knowledge Network to span across organizational boundaries, an Integrated Knowledge Network (which is ideal for Innovation) is created.

7.3.1.3. Multiple Organizations

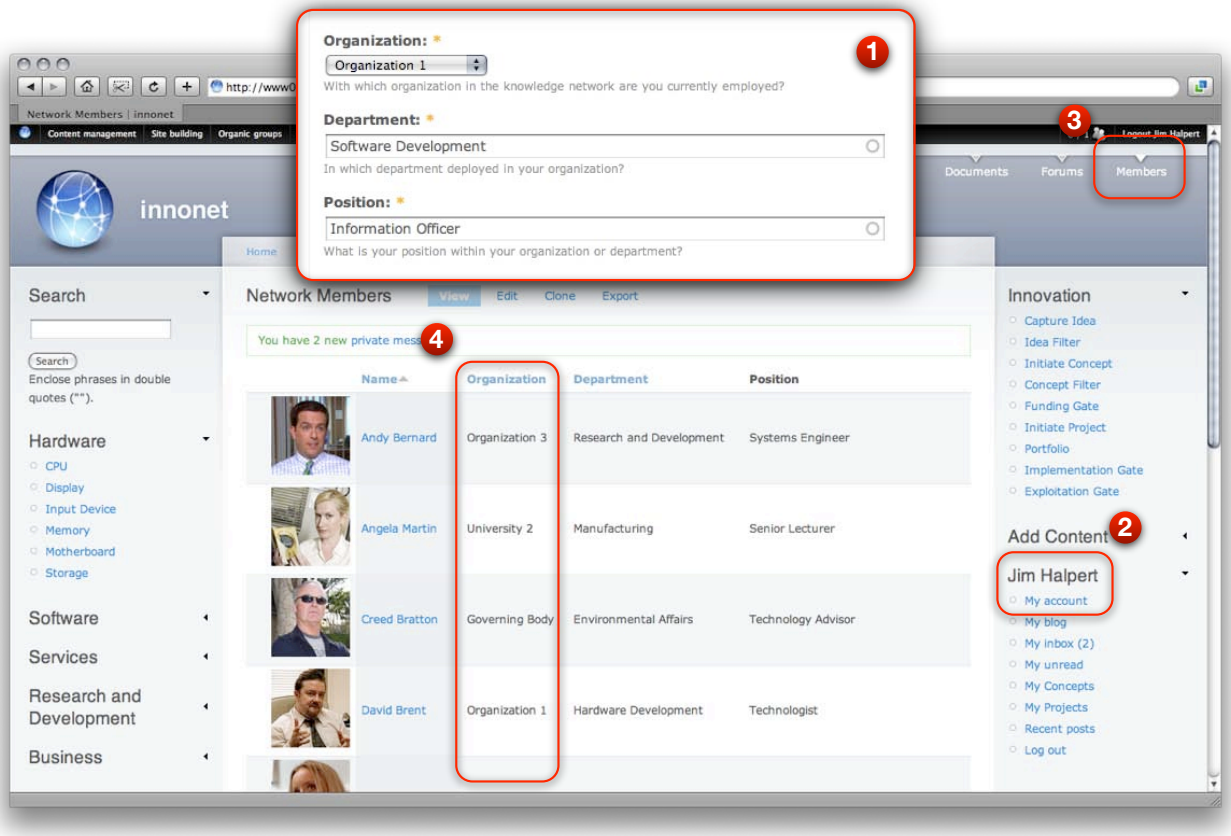


Figure 91 - The structure of user profiles is customized to reflect organizational affiliation

Assuming that the necessary agreements for the founding of the Integrated Knowledge Network between role-players in the Knowledge Supply Chain (refer to Chapter 3.1.3) are in place, individuals from various organizations are free to register their user accounts from wherever they please. An appointed network administrator will moderate these accounts prior to their activation.

The structure of user accounts is customized to include a number of fields that capture relevant information on users. These include birthdays, contact numbers and instant messaging usernames, but also organizational affiliation (see number 1 in Figure 91). The selectable options for organizational affiliation reflect the organizations involved in the knowledge network, and may include several enterprises, academic institutions, governing bodies and even that of a sanctioned market member. Post-registration, this information may be maintained in the account details of user profiles (number 2 in Figure 91).

A complete network member list may be viewed by following the “Members” link in the top navigation menu (number 3 in Figure 91). This listing displays industry-related information, including the organizational affiliation of members (number 4 in Figure 91).

Thus far a network model for knowledge object handling within an online environment that is accessible by individuals representing a number of organizations within a Knowledge Supply Chain, has been implemented. This constitutes the implementation of the Knowledge Network Architecture that is required for the support of Knowledge Work Processes and is a major step towards the proof of the hypothesis for this research project (refer to Figure 92).

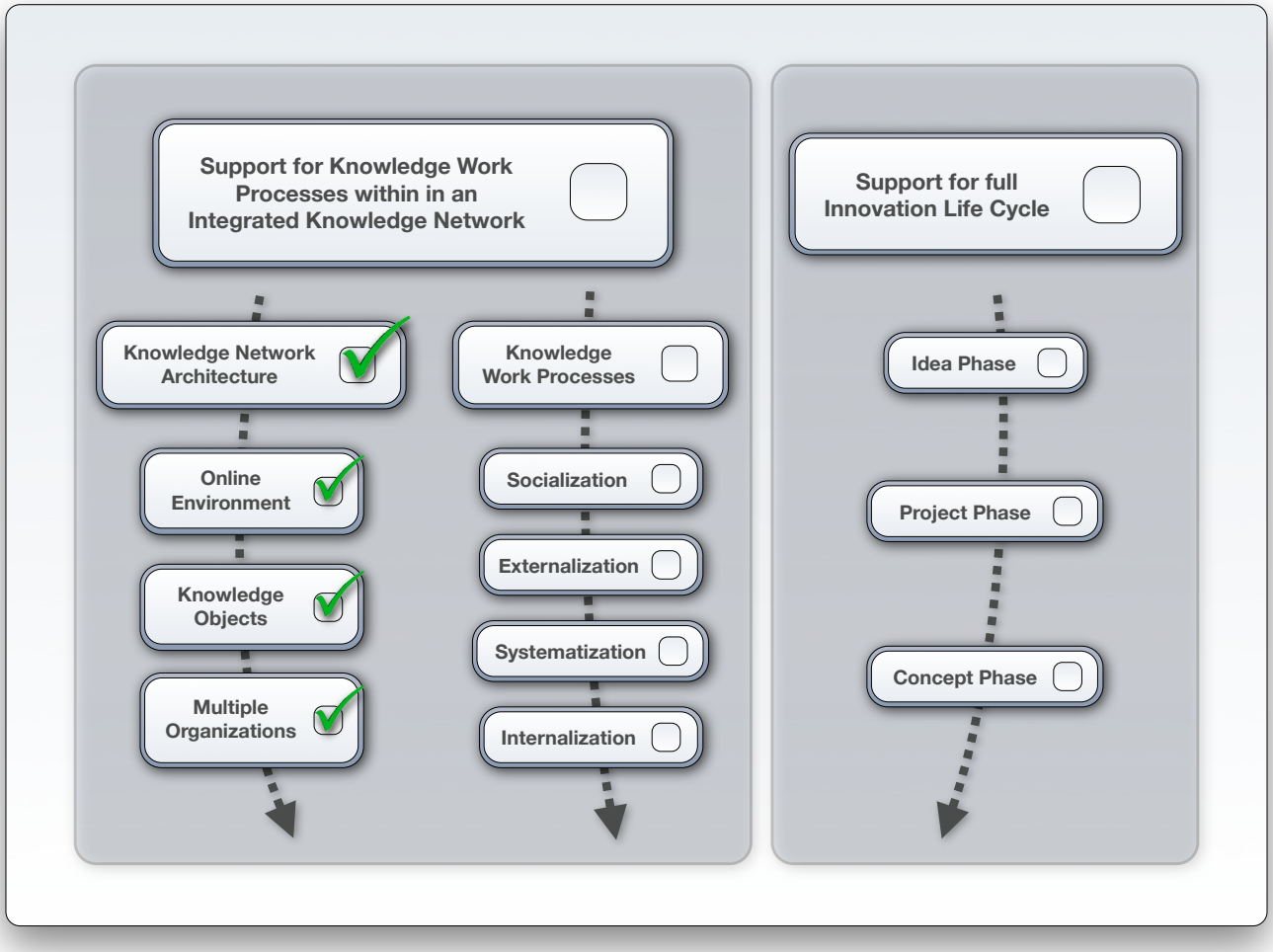


Figure 92 - The Knowledge Network Architecture is successfully implemented

The necessary support for Knowledge Work Processes within the Information System is discussed next.

7.3.2. Knowledge Work Processes

7.3.2.1. Socialization

a) Teamwork

The support for teamwork as a form of interaction is provided by the support for Innovation Projects within the system and is discussed in Chapter 7.4.

b) Communication linked to User profiles

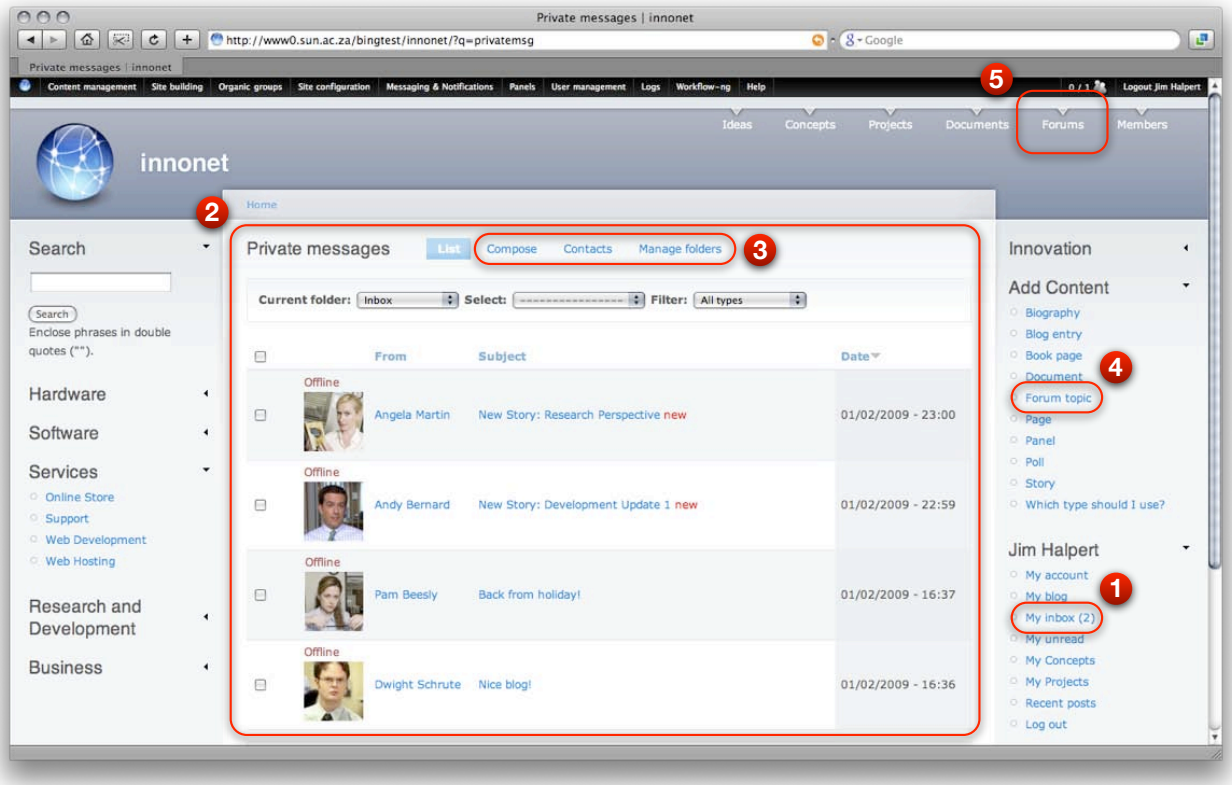


Figure 93 - Private messaging, Contact details and Forum discussions provide ample communication channels within the system

A private messaging service within the system allows network members to communicate directly with each other. Unread messages are shown in the user's inbox (see numbers 1 and 2 in Figure 93), and notifications of unread messages are displayed unobtrusively on every page of the system. Users may compose new messages in the TinyMCE interface (refer to Chapter 5.2.2) and create folders to organize their messages (number 3 in Figure 93). Contact details including telephone numbers and instant messaging usernames are available on user profile pages, and users may also use the forum discussions to converse (number 4 and 5 in Figure 93).

7.3.2.2. Externalization

a) Adding content

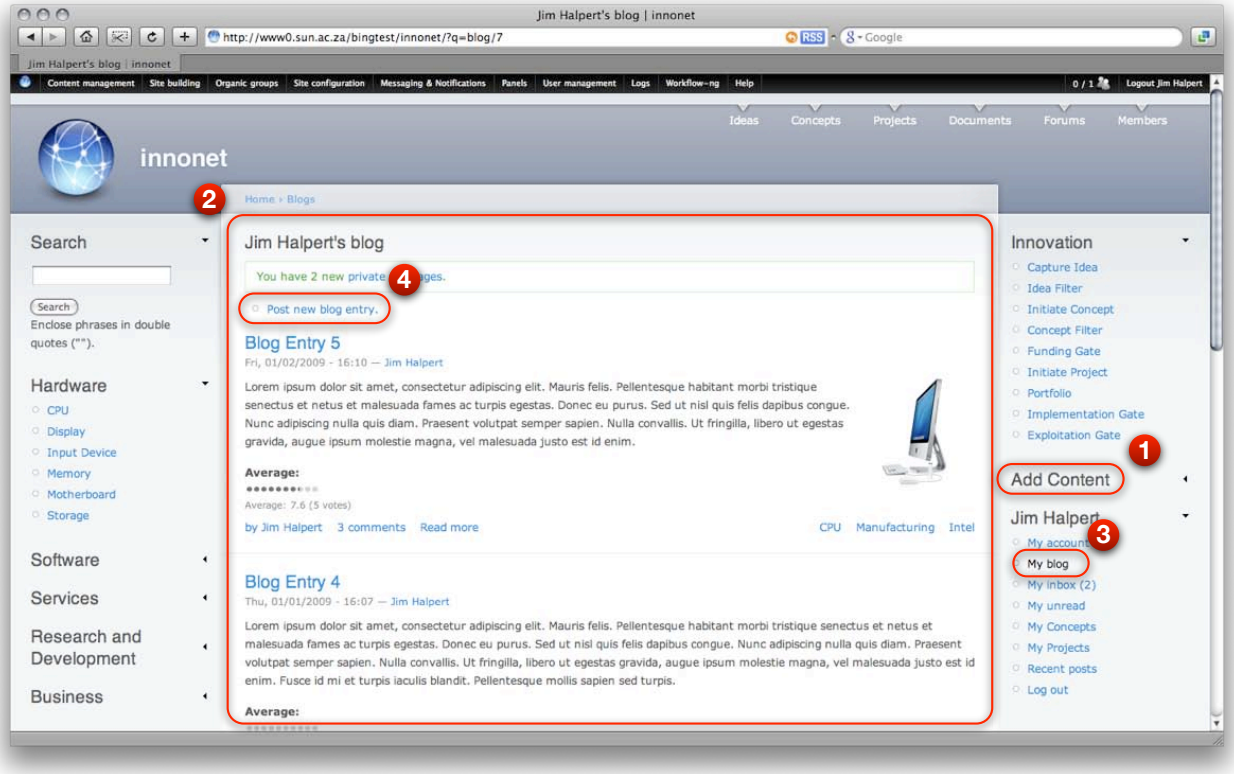


Figure 94 - A number of options are available for externalization, including personal blogs

Users may externalize their implicit knowledge with the help of a number of different content types (refer to Chapters 5.2.1 and 7.3.1.2) available from the “Add Content” menu (see number 1 in Figure 94), including a personal blog. Users may view their own blogs (numbers 2 and 3 in Figure 94) in a view that also includes a user-friendly link for adding a new blog entry (number 4 in Figure 94).

b) Comment and Rate Content

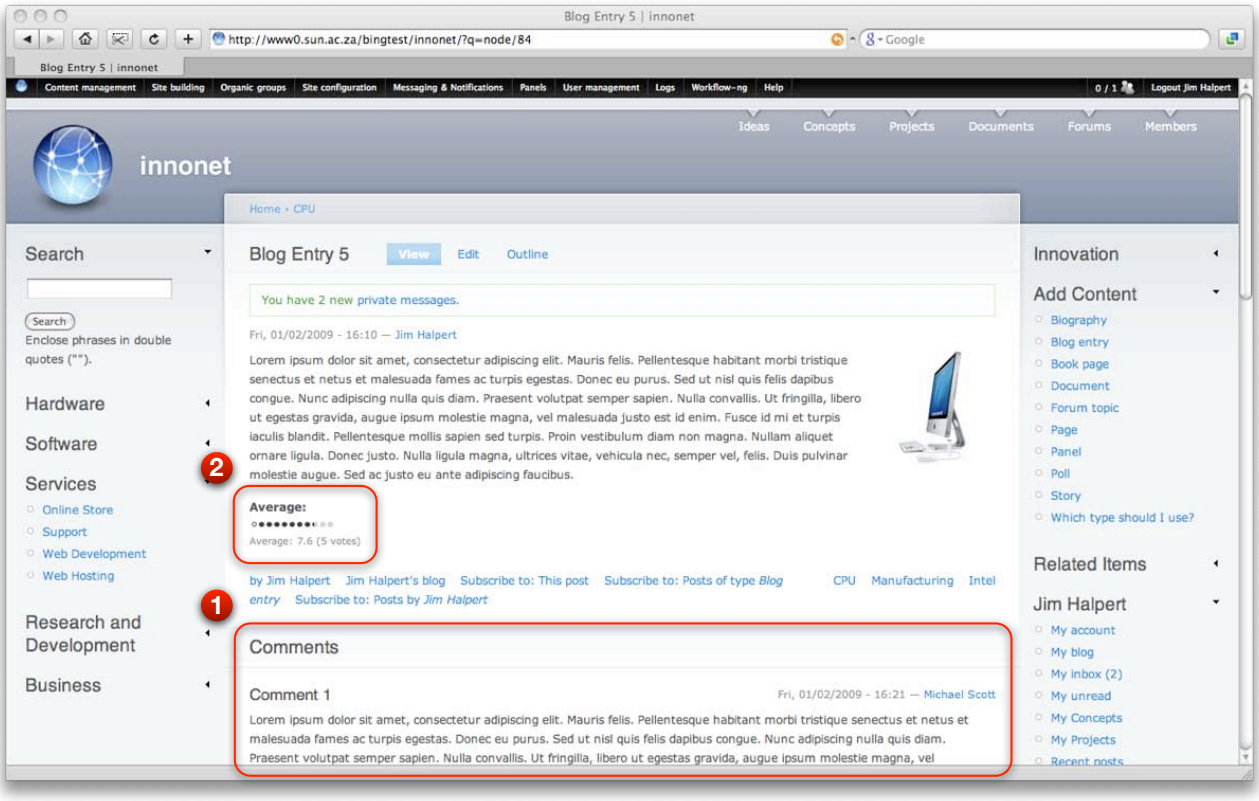


Figure 95 - Users may externalize by commenting and rating existing content

Apart from sharing their implicit knowledge through creating content of their own, users may comment on and rate the content of others (refer to Chapter 5.2.5). The Drupal system provides a user-friendly interface for adding comments to content (see number 1 in Figure 95). Users may also rate content with the use of the widget provided by the Fivestar module (refer to Chapter 5.2.6) (see number 2 in Figure 95). This rating interface allows users to add their score, undo it and also see the average rating for a specific content item.

7.3.2.3. Systematization

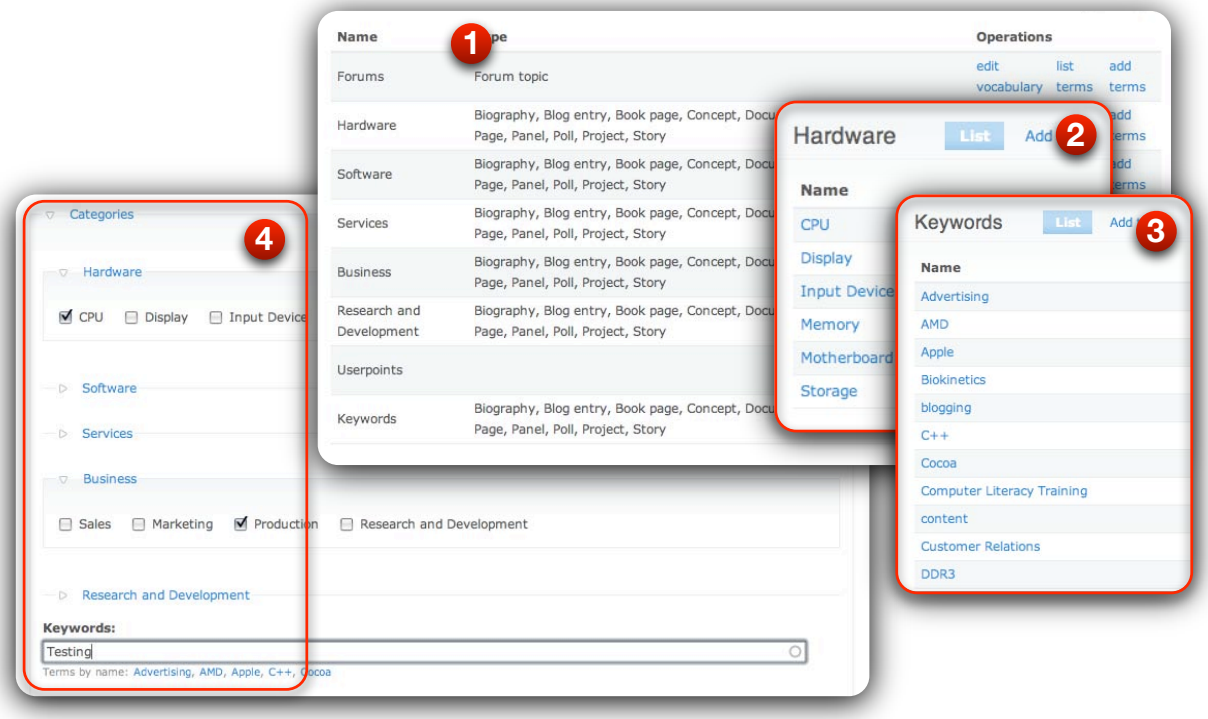


Figure 96 - A taxonomy scheme is used to classify knowledge objects and subsequently navigate the network knowledge base

The core Drupal Taxonomy module (refer to Chapter 5.3) is used to create a number of vocabularies (see number 1 in Figure 96) which may contain predefined terms (number 2 in Figure 96) or be set up to allow free tagging (number 3 in Figure 96). When adding content, users may tag their contributions with a predefined term or add a keyword that they feel is applicable (number 4 in Figure 96).

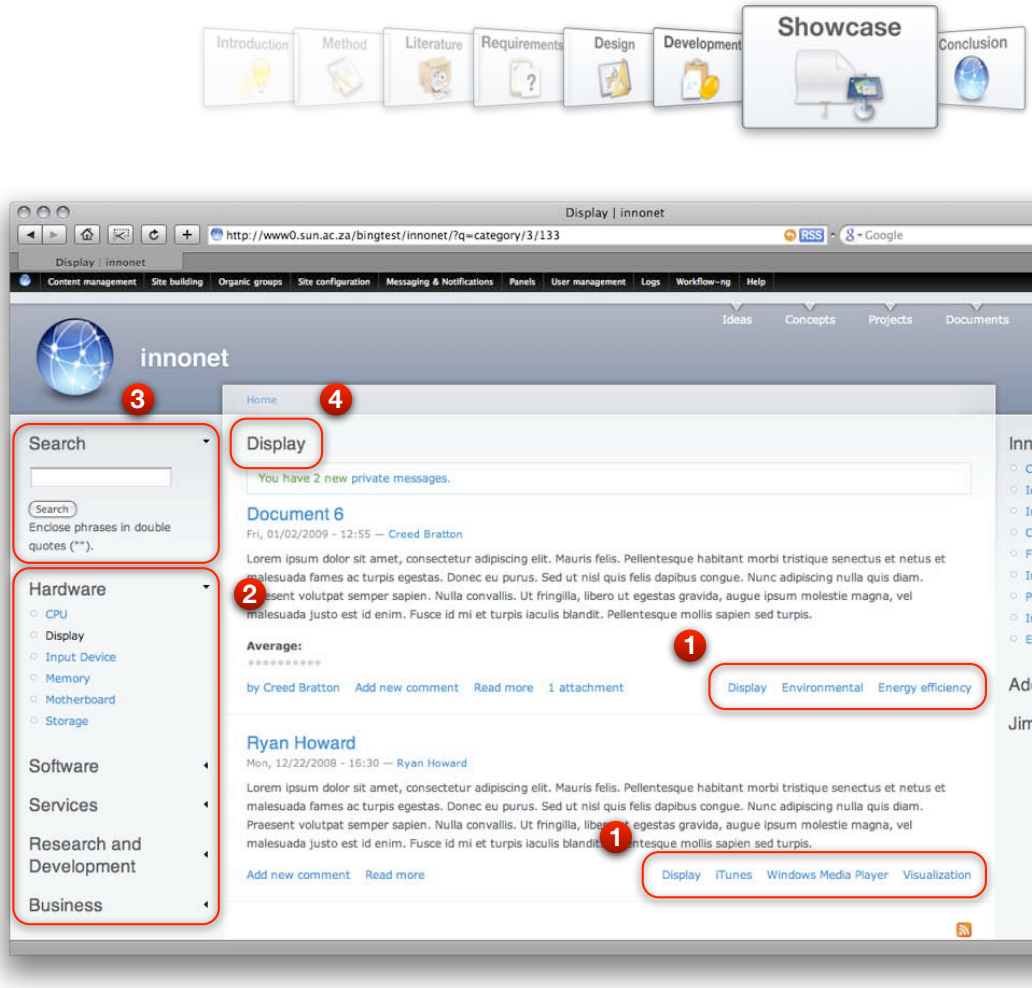


Figure 97 - The taxonomy scheme is used to navigate, search and query the network knowledge base

Once knowledge objects are classified (users may tag their biographies and documents as well as their contributed content), the tags are shown along with the content to give context to the display area (see number 1 in Figure 97).

The navigation structure in the left sidebar is configured to reflect the structure of the taxonomy scheme and users may use this to guide them in browsing through the network knowledge base. Users may also query the network knowledge base by following the taxonomy links connected to every content listing (number 1 in Figure 97) to display knowledge objects tagged with that specific term (number 4 in Figure 97). As was shown in Figure 90, content listings will reflect a wide variety of knowledge object types.

A search function is provided into which users may enter a wide variety of criteria, including taxonomy terms.

7.3.2.4. Internalization

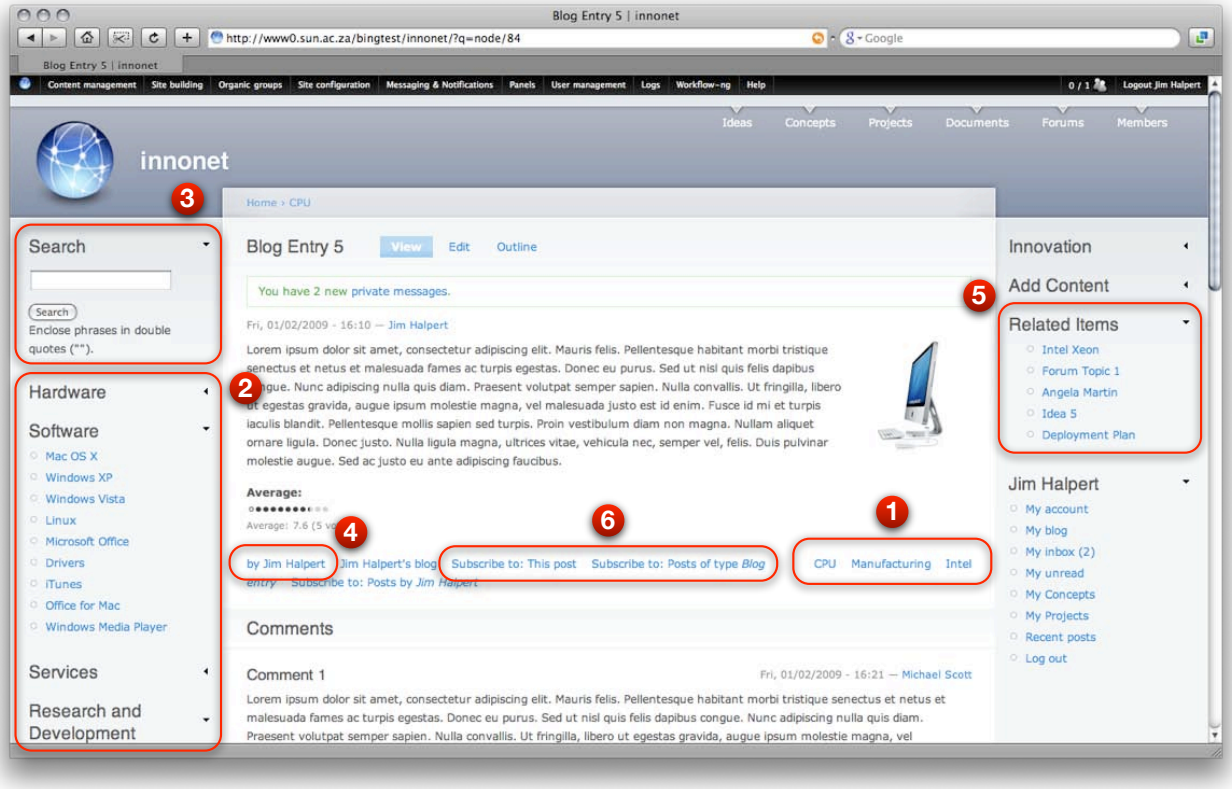


Figure 98 - Users are assisted in internalizing knowledge through a combination of system features

The navigation method provided by the taxonomy scheme (refer to Chapter 7.3.4.3) (see numbers 1 and 2 in Figure 98) helps users to identify relevant knowledge. The search function offers further assistance by allowing users to locate knowledge objects that fit certain criteria (number 3 in Figure 98). Users may also view all posts by a specific author (number 4 in Figure 98) if they find that user's contributions relevant.

The system further aids users to identify relevant content by providing intelligent suggestions on related items based on taxonomy similarities (number 5 in Figure 98). If users find a specific post interesting, they may subscribe to be alerted when that item is updated (or commented on) or when the author of that item makes another contribution (number 6 in Figure 98).

The look-and-feel of the system is prepared in a way that ensures simple and efficient display of information, thereby further enhancing internalization.

By providing support for socialization, externalization, systematization and internalization, the system ensures that all Knowledge Work Processes within the Integrated Knowledge Network is supported (refer to Figure 99).

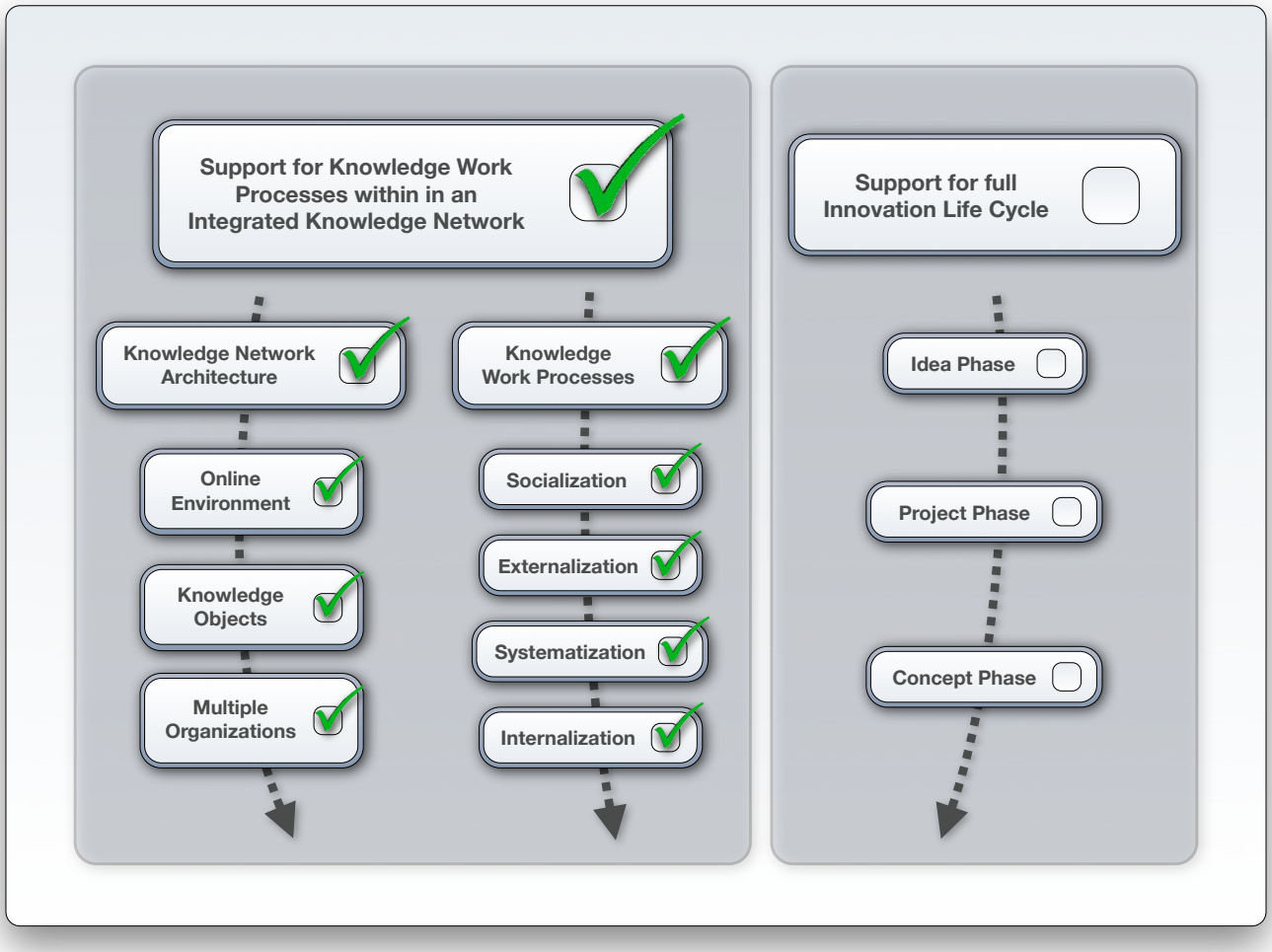


Figure 99 – The system supports Knowledge Work Processes within an Integrated Knowledge Network

7.4. Demonstration of support for full Innovation Life Cycle

7.4.1. Idea

a) Idea Capture

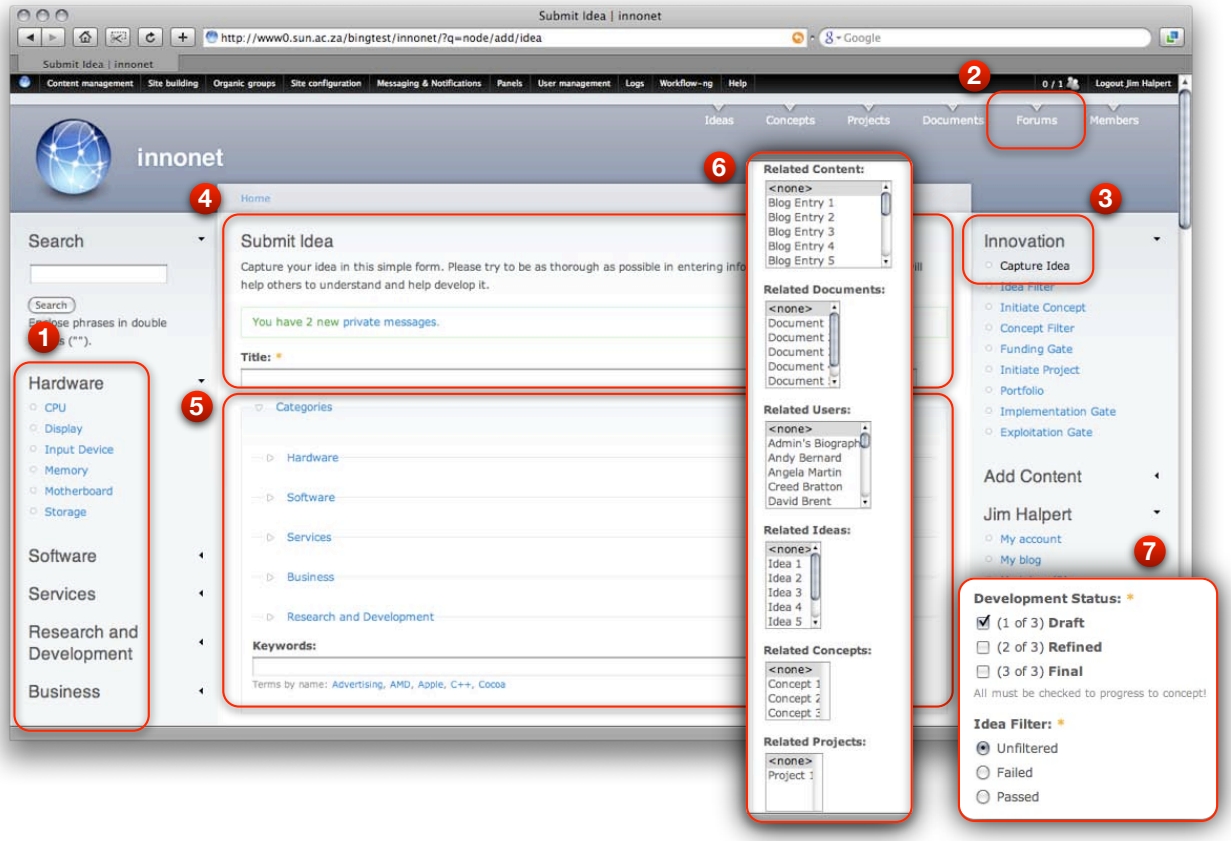


Figure 100 - Ideas are submitted in a form that captures context

Chapter 3.2.1.1 states that idea generation may be stimulated by the presentation of explicit knowledge (see number 1 in Figure 100), or it may be facilitated through workshops or forums (number 2 in Figure 100). The system provides and "Innovation" menu (number 3 in Figure 100) that includes a number of options related to the Innovation Life Cycle. The first of these options is "Capture Idea" and links to an idea submission form.

When capturing an idea the system encourages the user to be thorough in his or her approach to ensure that context s captured. Ideas are given titles (number 4 in Figure 100) and classified according to the taxonomy scheme (number 5 in Figure 100).

The structure of the Idea Object captured by the form includes two further sets of metadata. The first of these prompts the user to supply information on knowledge objects that may be related to the

generation of the idea. These objects may include regular content, documents, users, other ideas, or even concept and projects (number 6 in Figure 100). Note that by allowing users to reference projects as the source of their ideas, support is provided for the exploitation of projects as the source of further endeavors.

The second metadata set built into the structure of the Idea Object represents its progress through the Innovation Life Cycle (number 7 in Figure 100). The “Development Status” field includes options for “Draft”, “Reviewed” and “Final”. All three of these fields need to be filled to allow the idea to progress to the Idea Filter. The “Idea Filter” field itself consists op options for “Unfiltered”, “Failed” and “Passed” and is set by executive users during the Idea Filter stage of the Innovation Life Cycle (refer to Chapter 3.1.2.1).

b) Idea Display

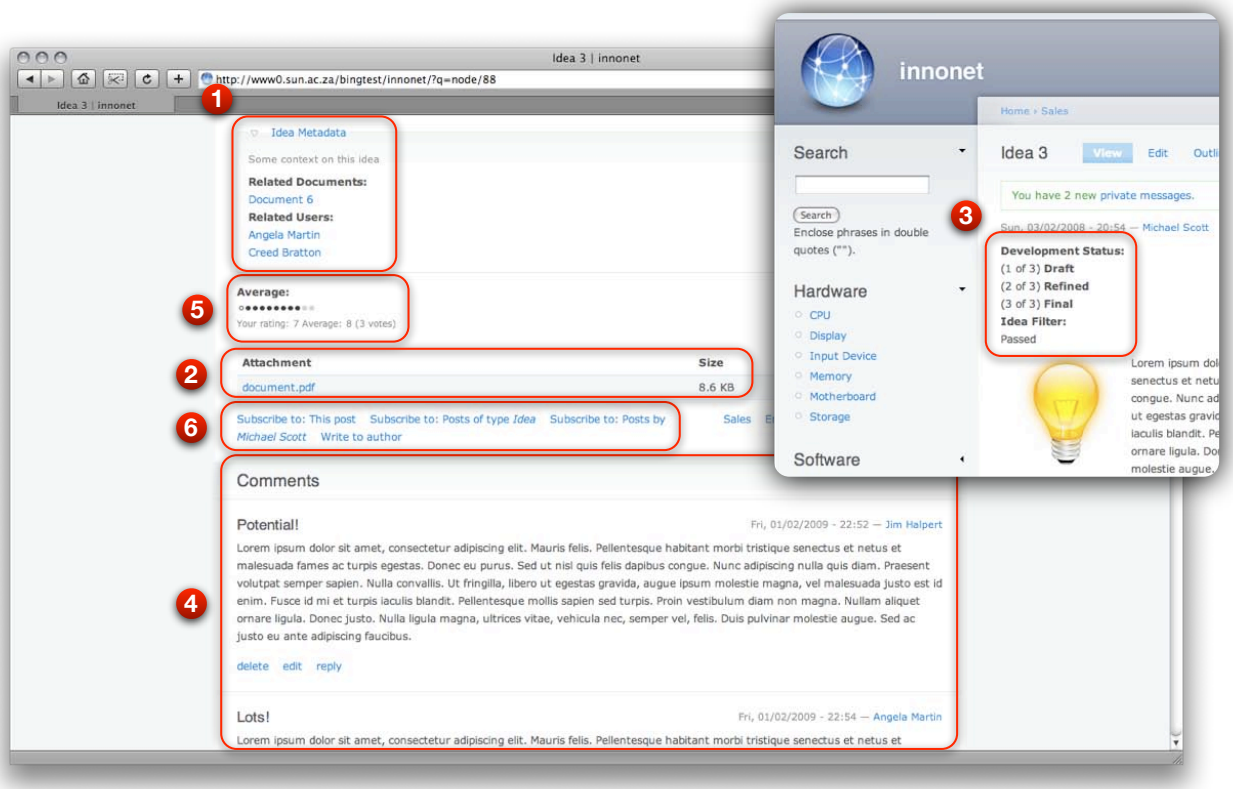


Figure 101- Ideas are displayed as Knowledge Objects within the system

Ideas are handled as Knowledge Objects within the system and are equipped with the same functions as other content items. When an idea is displayed, its metadata fields are shown prominently (see numbers 1 and 3 in Figure 101), along with any attachments to the object (number 2 in Figure 101). As with other Knowledge Objects, network members may comment on (number 4 in Figure 101) and rate (number 5 in Figure 101) ideas.

c) Idea Filter

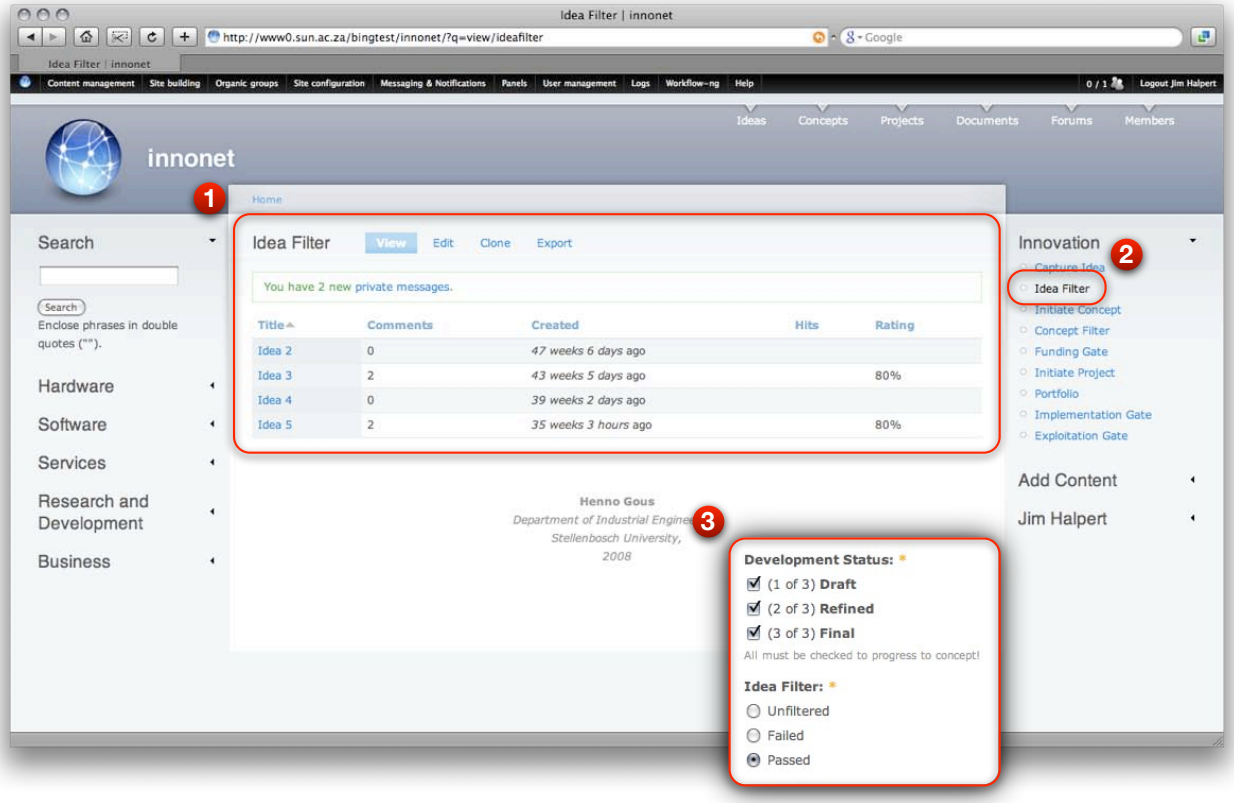


Figure 102 - The Idea Filter view summarizes and compares ideas

The Idea Filter view (see number 1 in Figure 102) provided to executive users in the “Innovation” menu (number 2 in Figure 102), provides an overview of Idea Objects in the network knowledge base that have reached the “Final” state in their development process (number 3 in Figure 102). The comment count, age and average rating of these ideas are displayed to the executive user, who has the assigned privilege to updated the state of Idea Object’s “Idea Filter” fields. The development status of unsuccessful ideas are set back to “Refined”, along with recording their visit to the Idea Filter as “Failed” in the filtering field.

7.4.2. Concept

a) Concept Initiation

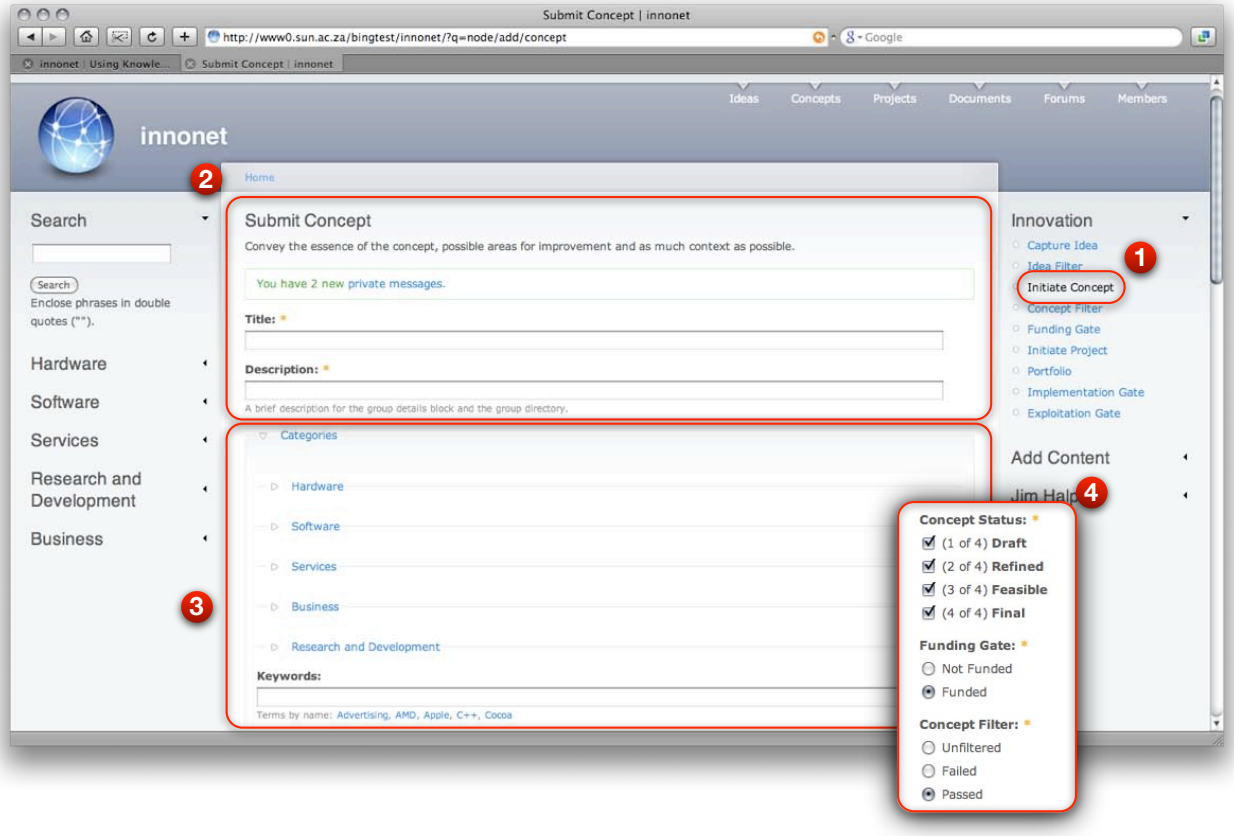


Figure 103 - Concepts are initiated with a simple yet comprehensive form

Administrator users are alerted when an executive user has changed an Idea Object's "Idea Filter" status to "Passed". This prompts the administrator user to initiate a Concept Object's development through a simple form that is available form the "Innovation" menu (see number 1 in Figure 103).

Concept Objects receive titles and descriptions (number 2 in Figure 103) and are classified according to the taxonomy scheme (number 3 in Figure 103). The structure of the Concept Object is customized to include metadata fields for the selection of Idea Object that are related to the Concept. This field allows multiple selections (refer to Chapter 3.1.2.2).

The structure of the Concept Object is customized further to include a field for tracking the development progress of the object (number 4 in Figure 103) and for reflecting its activity in the Concept Filter and Funding Gate.

b) Concept display

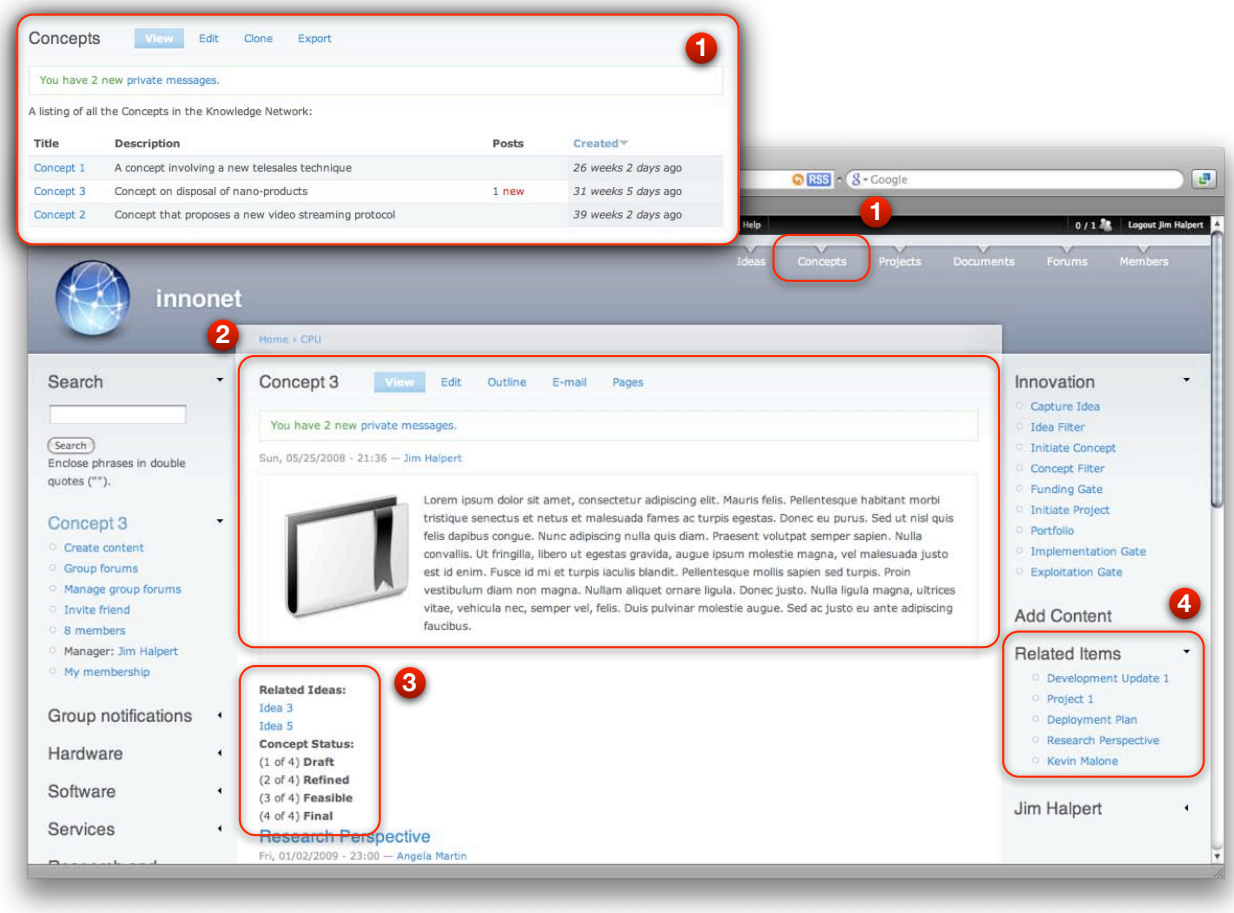


Figure 104 - Concept Objects are incorporated in the network knowledge base as knowledge objects

Concept Objects are incorporated in the network knowledge base as knowledge objects and will appear in content listings between other objects. Other content items are offered as “Related Items” to the Concept Object (number 4 in Figure 104), illustrating complete integration with the network knowledge base. A listing of all the Concept Objects in the network knowledge base may however be generated by following the “Concepts” link in the top navigation structure (see number 1 in Figure 104).

Concepts are displayed in a simple way (number 2 in Figure 104) that belies the complexity of the object. A basic view of the Concept Object will however display its metadata fields (number 3 in Figure 104).

c) Organic node groupings

Figure 105 - The Concept Objects acts as the central node of an organic node grouping

A closer inspection of the display interface for Concept Objects reveals the true complexity of the object. Apart from displaying the object's taxonomy classification (see number 1 in Figure 105) and any files attached to it (number 2 in Figure 105), the interface includes a Concept Menu in the left sidebar.

The Concept Object acts as the central node of an organic node grouping and the Concept Menu includes a link for viewing the group of network members that form a part of this group (number 3 in Figure 78). The menu further includes links for posting new content items directly into the group (the link and examples of such posts are denoted by number 4 in Figure 105). A forum discussion dedicated to the group's activities is also offered (number 5 in Figure 105).

User may comment on posts that form a part of the group, and they may rate the Concept Object (number 6 in Figure 105), thereby rating the grouping itself. As with all other posts, users may subscribe to be alerted upon any activity relating to the group.

d) Concept Filter and Funding Gate

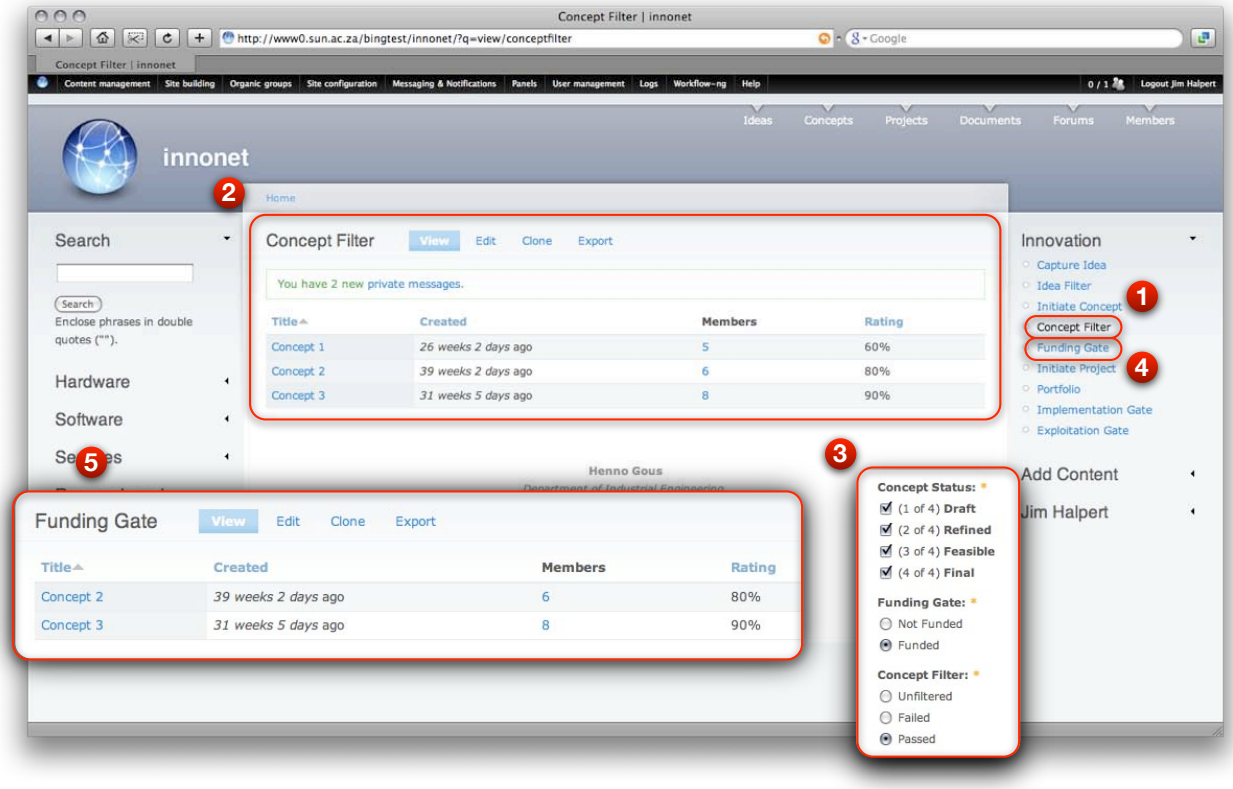


Figure 106 - The Concept Filter and Funding Gate

Executive users are allowed access to the Concept Filter and Funding Gate via the “Innovation” Menu (see numbers 1 and 4 in Figure 106). The Concept Filter provides an overview of Concept Objects that have reached the “Refined” state in their development progress (number 2 in Figure 106), while the Funding Gate only shows Concept Objects that have achieved the “Final” state (number 5 in Figure 106).

Executive users have the privileges to adjust the states of Concept Objects’ “Concept Filter“ and “Funding Gate” fields, thereby advancing them in their development process (number 3 in Figure 106). In the case of the “Funding Gate” field being set to “Funded”, an administrator user is prompted to initiate a Project Object.

7.4.3. Project

a) Project Initiation

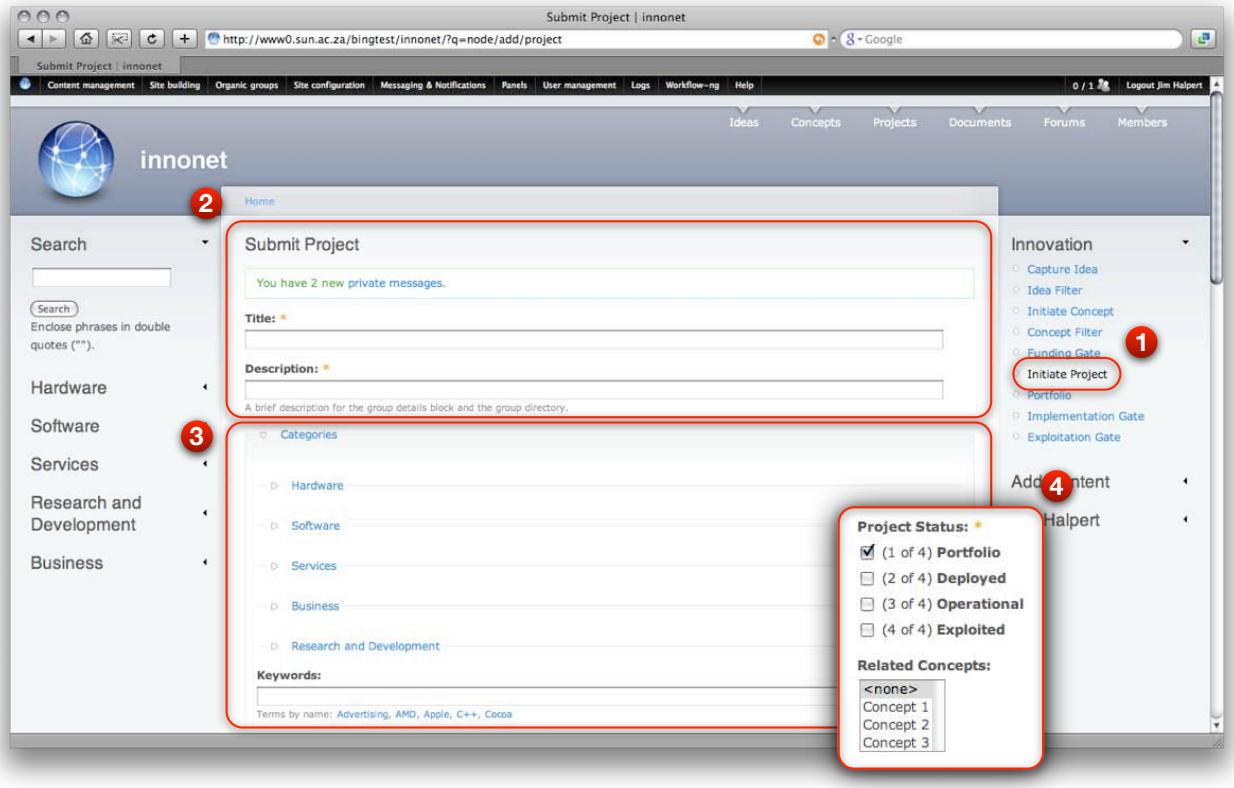


Figure 107 - A Project Object is initiated via a simple interface

Project Objects are greatly similar to Concept Objects, and offer many of the same functions.

A Project Object is initiated with the “Initiate Project” link in the “Innovation” menu (see number 1 in Figure 107), leading to a simple form allowing an administrator user to enter a title and description for the object (number 2 in Figure 107). Project Objects are knowledge objects and are therefore incorporated in the taxonomy scheme of the network knowledge base (number 3 in Figure 107).

The structure of the Project Objects includes a metadata field to indicate Concept Objects that lead to the initiation of the Project Object (refer to Chapter 3.1.2.4) (number 4 in Figure 107). Another field is included in the structure to track the object’s development status (number 4 in Figure 107).

b) Project display

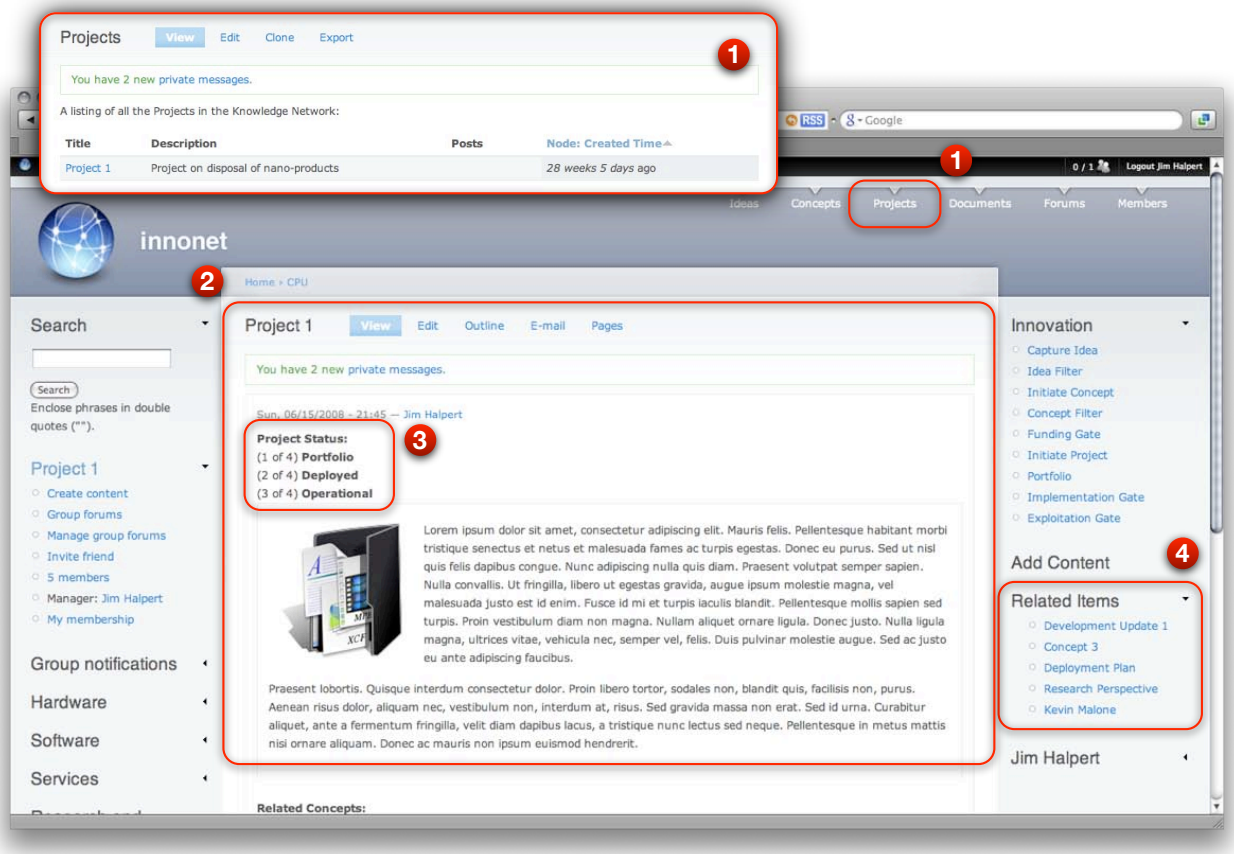


Figure 108 - Project Objects are included in the network knowledge base as Knowledge Objects

Project Objects are included in the network knowledge base as knowledge objects and will therefore appear in regular content listings according to taxonomy term, age, etc. A listing of only the Project Objects in the network knowledge base may however be obtained by following the “Projects” link in the top navigation structure (see number 1 in Figure 108).

The display interface for a single Project Objects is simple (number 2 in Figure 108) and clearly denotes its development status (number 3 in Figure 108). As Project Objects completely integrate with the network knowledge base, the display interface also includes a listing of knowledge objects that are related to the Project Object being displayed.

c) Organic node grouping

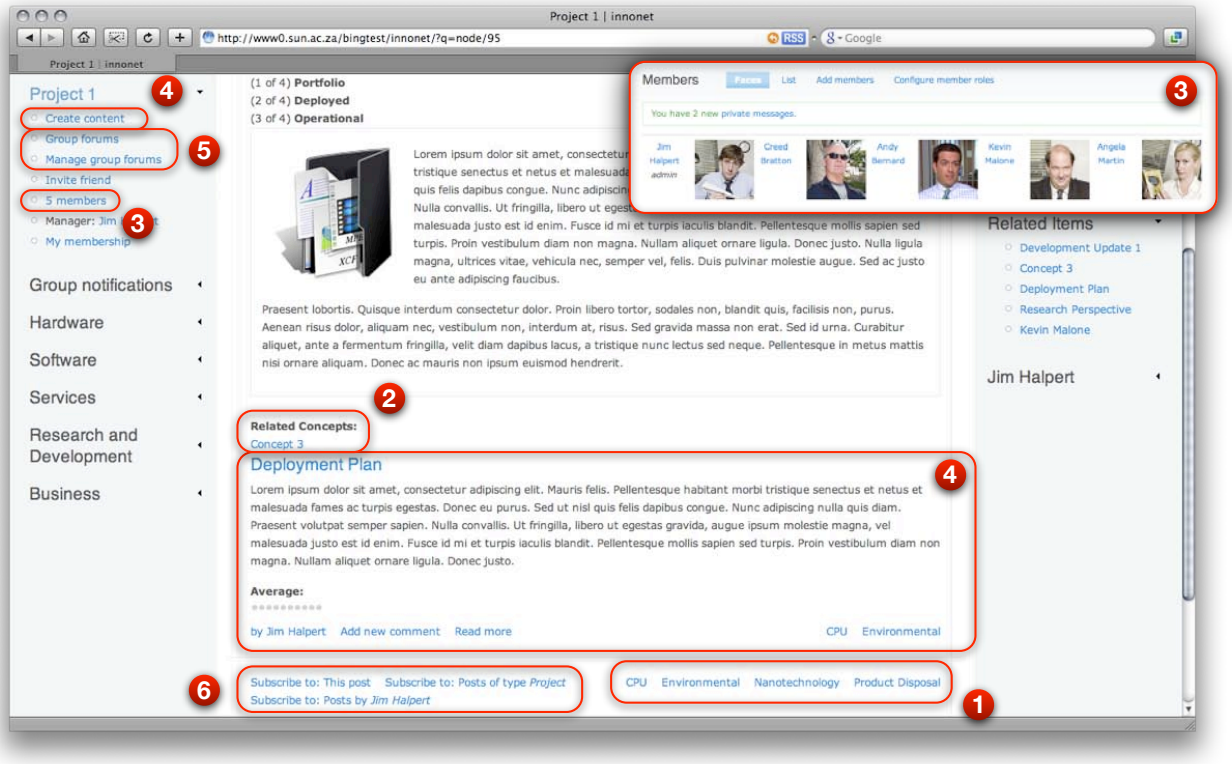


Figure 109 - Project Objects form the central nodes of organic node groupings

Like Concept Objects, Project Objects form the central nodes of organic node groupings and therefore the detailed display interface is very similar.

Project Objects may be classified according to the network knowledge base taxonomy scheme (see number 1 in Figure 109) and will clearly display their related Concept Objects (number 2 in Figure 109). A link to a view of network members involved in the project is provided in the Project Menu (number 3 in Figure 109), along with links for posting new content directly into the group (the link and an example of such a posting is denoted by number 4 in Figure 109) and the dedicated project forum (number 5 in Figure 109).

Users may subscribe to be alerted of any activity within the Project Object (number 6 in Figure 109).

d) Innovation Portfolio, Implementation Gate and Exploitation Gate

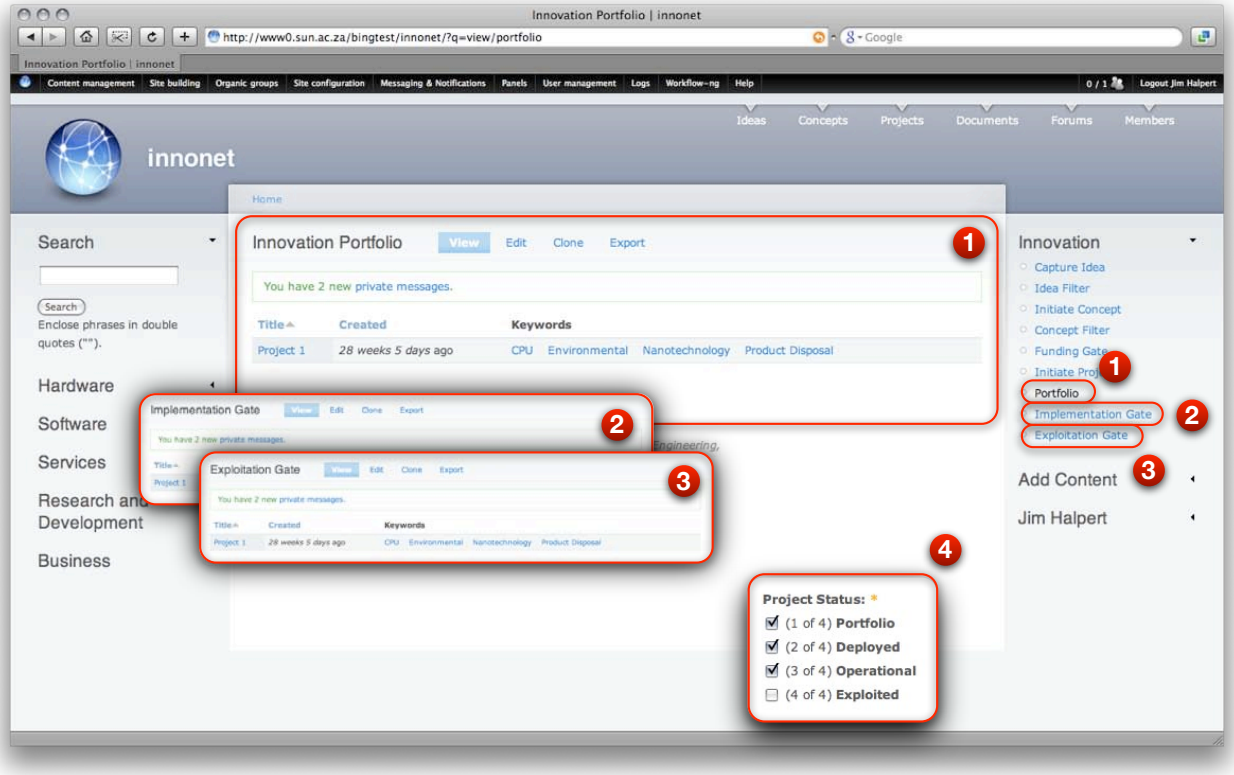


Figure 110 - The Innovation Portfolio, Implementation Gate and Exploitation Gate guides innovation project development

The “Innovation Portfolio” (see number 1 in Figure 110), “Implementation Gate” (number 2 in Figure 110) and “Exploitation Gate” (number 3 in Figure 110) are content views only available to executive users.

The “Innovation Portfolio” shows all Project Objects in the network knowledge base, the “Implementation Gate” only those ones that have reached the “Deployed” state and the “Exploitation Gate” only those that have reached the “Operational” state.

Executive users also have the privileges to change the state of Project Objects’ “Project Status” field to reflect their progress.

Support for the full Innovation Life Cycle has been added to support for Knowledge Work Processes within an Integrated Knowledge Network. This completes the requirement set for an Integrated Knowledge Network ICT Architecture, proves the hypothesis put forward in Chapter 3.4, and therefore solves the problem stated in Chapter 3.3 (refer to Figure 111).

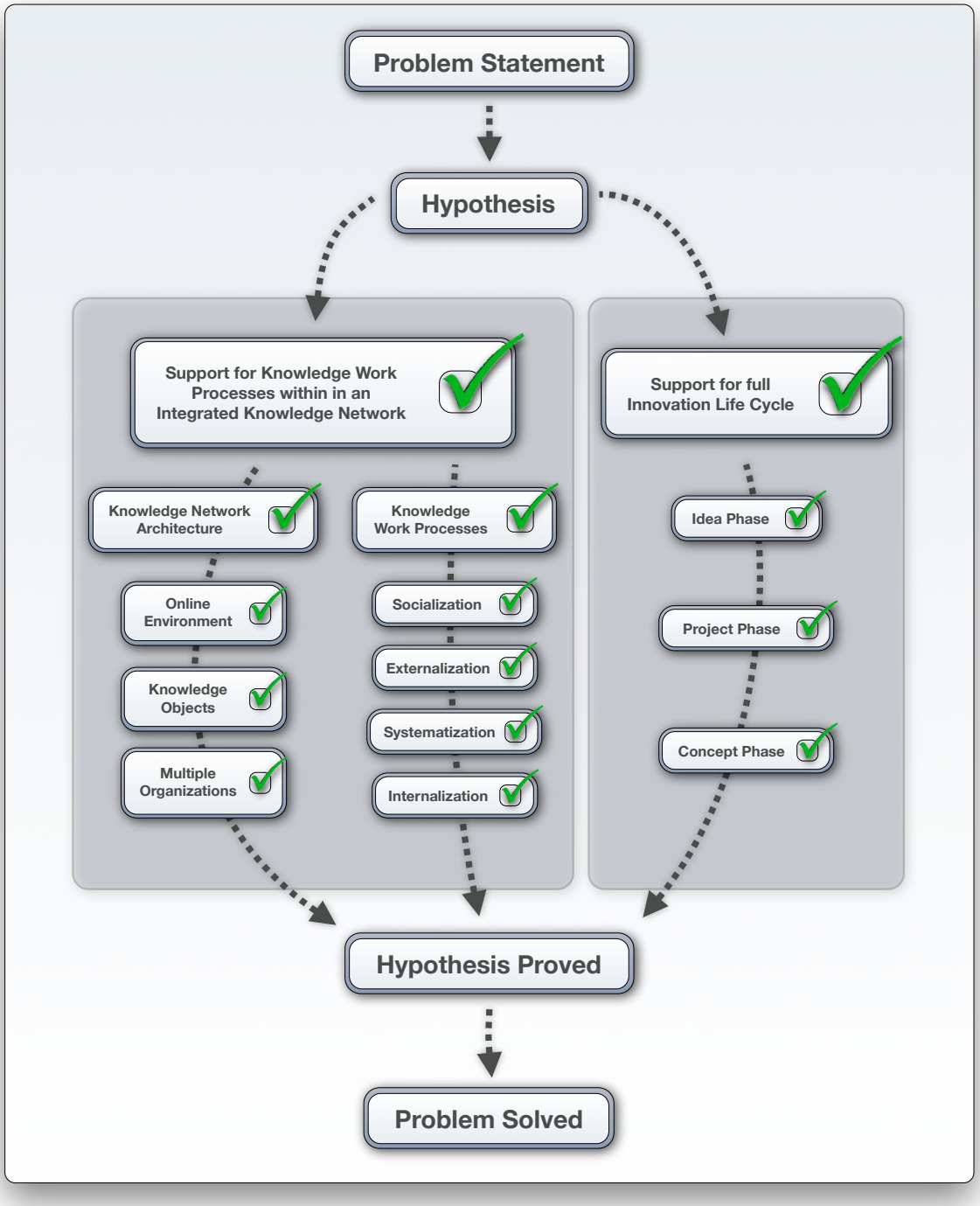


Figure 111 - The developed Information System's features fit those needed to prove the hypothesis and solve the problem

Chapter 8

Conclusion

SDLC Step 8: Implementation

"Includes the implementation of the system in a production environment, and resolution of problems identified in the Integration and Test phase."

- Wikipedia

SDLC Step 9: Operation and Maintenance

"Describes tasks to operate and maintain information systems in a production environment."

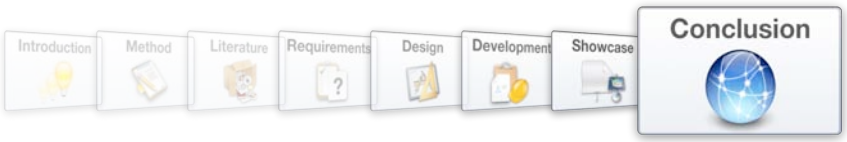
- Wikipedia

SDLC Step 10: Disposition

"Describes end-of-system activities. Emphasis is given to proper presentation of data."

- Wikipedia

Chapter 7 presents a demonstration of the functionality of the information system that was developed as a solution to the refined problem statement in Chapter 3.



8.1. Summary

This research project was aimed at designing and developing an Information System that may be used to link the wide range of role-players that are involved in the Innovation Process. As system development was at the heart of this project, the Systems Development Life Cycle was used as a guide.

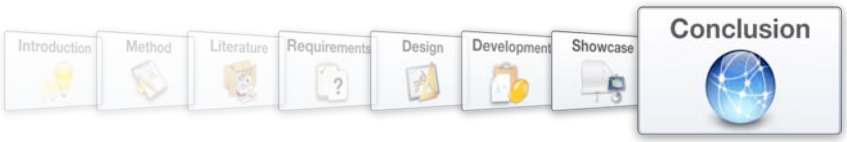
It was discovered that the role-players mentioned above are connected by the flow of knowledge between them, and that together they form a Knowledge Supply Chain. It was further noted that the management of knowledge within this supply chain is not limited to the archiving of explicit knowledge in repositories. Role-players in the Innovation Process transfer and create implicit and tacit knowledge over and above the obvious explicit knowledge that they share.

Knowledge Networks offer a modern and fresh approach to knowledge management that incorporates all types of knowledge. It achieves this by combining organizational and ICT elements in its architecture, thereby combining two domains that are successful in the management of tacit and explicit knowledge respectively. The network structure that a Knowledge Network employs is flexible and dynamic and delivers knowledge transfer at a rate unrivalled by other Knowledge Management strategies.

A further upshot of having an organizational element at its core is that the same principles that drive the Knowledge Network within a single organization may be used to deliver rapid and flexible Knowledge Management between organizations. Tacit knowledge is integrated with explicit knowledge and manipulated as knowledge objects - irrespective of the organizational affiliation of the tacit knowledge source. This has lead to the formalization of the Integrated Knowledge Network as a cutting edge strategy for inter-organizational Knowledge Management. It therefore comes as no surprise that Integrated Knowledge Networks are seen as the future of collaboration between role-players in the Innovation Process.

That being said, exploration of modern Innovation Management software seems to indicate that few ICT solutions have attempted to exploit the potential of the Integrated Knowledge Network. Even fewer projects have connected the Integrated Knowledge Network with the latest available Web technologies. These technologies offer the latest developments in the remote connectivity, content management, media-rich environments, community building, social networking... the list goes on.

Research however uncovers a striking similarity between the requirements of an Information System that will support the Integrated Knowledge Management as a cradle for Innovation in a modern environment, and the exact features many of these technologies boast. Closer inspection of the Web



technology landscape indicated that open-source Content Management Systems are some of the most rapidly developing online projects, with WordPress, Joomla and Drupal leading the way. A comparison of these packages however indicated that Drupal had the edge in a number of deal-clinching features.

Drupal was therefore implemented as the basis of an Information System that supports an Integrated Knowledge Network. The Drupal core package is comprehensive and offers most of the functionality that is needed, but where it came up short, extension modules contributed by the vibrant developer community that drives the Drupal project, always had the answers.

The review of relevant literature indicated that connecting the role-players in the Innovation Process was only half the battle won, as many Innovation Management projects that did in fact connect the necessary parties, still failed. A lack of understanding of the intricacies of the Innovation Life Cycle seemed to be the problem, and the Information System developed in this project was therefore equipped with a roadmapping capability. This function nurtures Innovation Projects through their infancy as Ideas, leads them through the adolescence as Concepts and monitors them through their adult development as Projects.

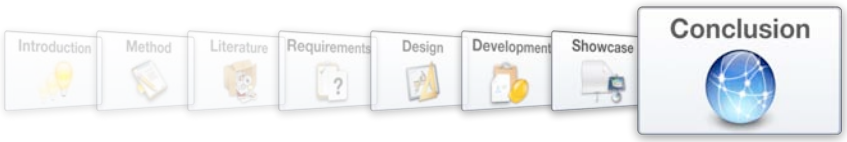
Combining the developed system's ability to connect role-players in the Innovation Process with its capability to guide the Innovation Projects these role-players are involved in, results in a system that offers the functionality specified in the research hypothesis.

It may therefore be concluded that the Information System developed in this research project offers the functions deemed necessary to support and enhance Innovation in a globalized modern economy.

8.2. Applicability of the Research

The introduction to this research report alluded to economic downturn and the hardships that this brings to enterprises. Leading global organizations are however turning to Innovation as a way of surviving the tough times and to emerge as a stronger entity once the environment improves.

Research into an Information System Architecture that may support the Innovation projects of these organizations on a globally distributed level is therefore highly applicable, and uncovers several opportunities for further research.



8.3. Further Research

The following questions remained unanswered or came to light during this research project, and raises the need for further research:

Does it work?

The scope of this research project did not include a full testing phase within a production environment. The claim that this study lays to a working system is therefore based upon the successful proof of the research hypothesis. Research suggested that the combination of features that were designed, developed and eventually demonstrated are sufficient to support Innovation. It may however be that further insight in the Innovation process will lead to the identification of additional necessary features, or the augmentation of some of the currently known ones.

Testing the system in a full production environment will be the only conclusive proof of an effective solution, as even a posthumously applied case study will not capture the complexities of real-time Innovation Management.

How will this be implemented?

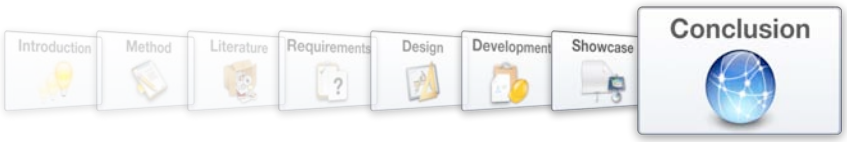
In its approach to the organizational background to the setup of an Integrated Knowledge Network, this study assumed that all the necessary agreements for the initialization of the network were already in place. It may however be the case that some of the particulars of these agreements need to be reflected in the Integrated Knowledge Network ICT Architecture.

Research into the adoption of such a system in an Integrated Knowledge Network is required.

What about intellectual property?

The nature of the collaboration that this research project is aimed at, includes no excessive emphasis on personal intellectual property. It is assumed that the philosophy of an open innovation model in which free collaboration is seen as mutually beneficial to all parties, is adopted by organizations in the network.

This approach may however be idealistic and research into the implementation of a system such as the one proposed in this project should include consideration for protection of intellectual property.



Is the support for projects sufficient?

The Information System developed in this study does not offer detailed support for the management of innovation projects. The approach to support for projects rather focused on acting an information hub that is used to provide centralized access to project information, and to integrate projects as knowledge objects into the network knowledge base.

Further research may however investigate ways in which the system may be improved to support specific types of projects. Such research should consider improving the detailed support for projects in the generic roadmap employed, while also considering the impact of implementing the system in an industry environment that has specific project requirements.

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Appendix A – Knowledge Network ICT Architecture Review

Seufert [54] proposes a classification framework for tools that may be used to build the architecture that supports a Knowledge Network (refer to Figure 112). This classification framework includes organizational, as well as information and communication technology tools. Given the problem statement in Chapter 3.3 however, only the latter will be reviewed for the purpose of this research.

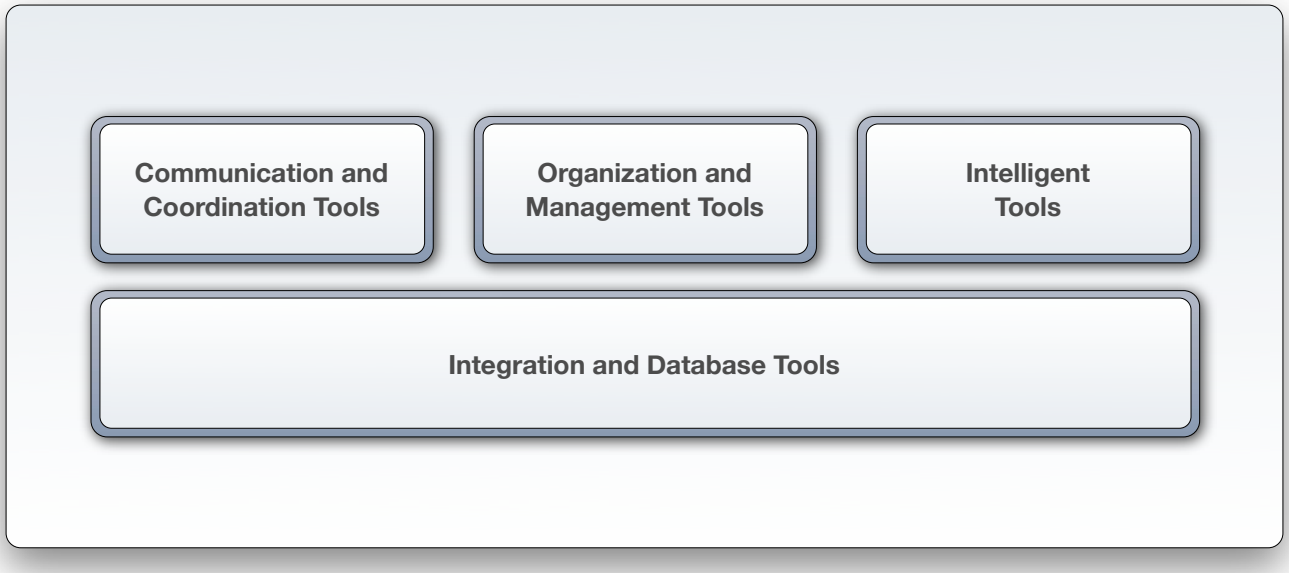

Figure 112 - Classification framework for tools that may be used to build a Knowledge Network Architecture

10.1. Integration and Database Tools

Integration tools are essential for knowledge management and especially for knowledge networks. Integration tools are tasked with the integration of technology, knowledge work processes, knowledge objects (different knowledge formats) and various support levels (individual, group, company).

The following tools may be considered as part of this class:

- Internet/Intranet technologies
    - Content Management Systems

    - Hypertext/-media
    - Search engines and catalogs
    - Yellow pages
    - Expert maps
    - Audio- and Video-communication
- Web-enabled applications
    - Web-based document management
    - Web-based workflow management
- Knowledge Management Suites
- Databases, data dictionaries
- Repositories
- Data warehousing

10.2. Communication and Coordination Tools

The following tools may be considered as part of this class:

- Document Management and Archiving
- Workflow Management
- Messaging/E-mail
- Calendaring/Scheduling
- Group decision support systems
- Real-time conferencing systems
- Non-real-time conferencing systems
- Learning platforms
- Group editing/group document handling (e.g. wiki documents)
- Community tools

10.3. Organization and Management Tools

The following tools may be considered as part of this class:

- Personal information management
- Decision support systems
- Executive information systems
- Simulation and modeling tools
- Visualization tools
- Creativity tools
- Measuring tools

10.4. Intelligent Tools

The following tools may be considered as part of this class:

- Intelligent agents
- Data mining
- Text mining
- Skill mining
- Business intelligence
- Categorization/clustering tools
- Problem solving tools
    - Neural networks
    - Rule-based systems

10.5. Knowledge Network ICT Architecture Model

Raimann [39] proposes a model for the Knowledge Network Architecture which combines a number of tools mentioned in the previous sections.

Main functional elements of this model include:

- Basic services to support Knowledge Networks

  The knowledge network may be supported by directly supporting the Knowledge Work Processes within the network, or by supporting the life cycle of the network itself. These Knowledge Work Processes represent all knowledge locating/capturing, sharing/transferring and creation activities that take place between actors in the network.

- Provision of “work spaces”

  The Knowledge Network is not removed from the organization(s) to which it is linked and should therefore address its actors with appropriate services. These services should include connected ”work spaces” on individual, network and organizational levels.

- Knowledge base

  The knowledge base includes and integrates explicit as well as tacit and implicit knowledge objects. These knowledge objects are at no point static and are continually growing. Comprehensive meta-information about the knowledge objects are also included in the knowledge base and may be used to give structure and context.

- Performance measurement

  The performance of a knowledge network may be partially measured according to the success of its ICT architecture. Statistics on system and knowledge usage may be used to gauge this performance.

- Knowledge portal

  The access tier of a knowledge network architecture is realized as a web-browser-based knowledge portal in order to realize a “single point of access” on the different knowledge objects and systems. Ideally, such a knowledge portal should be configurable and adaptable to the needs of knowledge networks as well as the needs of their members.

The suggested architecture model might be realized as a typical 3-tier-architecture (without the network and integration tier). Underneath the access tier, the server tier and the data tier, the network

and integration tier represent the background for this architecture. Today, open and standardized internet/intranet-technologies are the predominantly used technologies to realize enterprise-wide or worldwide accessible applications. Global connectivity is crucial, since future corporations will have to share knowledge not only within the organization, but also with different alliances, universities, the public, certain individuals, and even competitors located in different places around the world (Högberg [23]).

10.6. The case for Content Management Systems

A content management system (CMS) is a computer application used to create, edit, manage, search and publish various kinds of digital media and electronic text. Content Management Systems may be divided into three categories:

1. Enterprise Content Management Systems (ECM)

   An enterprise content management system is concerned with content and documents related to the organizational processes of an enterprise. Its purpose is to manage the organization's unstructured information content, with all its diversity of format and location.

2. Web Content Management Systems (WCM)

   A web content management system is a CMS designed to simplify the publication of Web content to websites, in particular allowing content creators to submit content without requiring technical knowledge of HTML or the uploading of files.

3. Component Content Management Systems (CCM)

   A component content management system is concerned with the content within documents. It can locate and link content at any level of organization, and it is used to build publications out of re-usable fragments of content.

Considering the problem statement for this research as proposed in Chapter 3, a solution is required which combines features from enterprise- and web content management systems.

Content Management Systems are classified as Integration and Database Tools according to Seufert's classification framework. Their integration and connectivity capabilities make them ideally suited to form the platform for a Knowledge Network ICT Architecture. Content Management Systems are furthermore purpose-built to give structure to a knowledge base.

A multitude of open-source CMS packages are freely available and are ideal for research purposes. A vibrant developer community that contributes extensions to the core package supports most of these packages. The further potential of CMS platforms is therefore that their functionality is not limited to that of the core system, as they may be extended and customized to include most of the tools listed in sections 10.1 to 10.4. The level to which this customization can take place relies on the flexibility of the core package and the extensions that are available. Most of the active CMS packages are regularly updated with new feature sets that keep the system up to date with web standards. CMS packages also offer built-in workflow management, which allows for content moderation.

A review of a number of open-source CMS packages will provide some background for the choice of a CMS to form the foundation of the Knowledge Network Architecture in Chapter 5.

10.7. Review of open-source Content Management Systems

The sheer volume of open-source CMS packages that are available makes it impossible to seriously consider every single one. A comprehensive CMS market survey was however done by Schreves [52] in 2008 and the ensuing report found that three CMS packages dominated the market:

1. WordPress
2. Joomla!
3. Drupal

10.7.1. WordPress

WordPress has a templating system, which includes widgets that can be rearranged without editing PHP or HTML code, as well as themes that can be installed and switched between. The PHP and HTML code in themes can also be edited for more advanced customizations. WordPress also features integrated link management; a search engine-friendly, clean permalink structure; the ability to assign nested, multiple categories to articles; multiple author capability; and support for tagging of posts and articles. Automatic filters that provide for proper formatting and styling of text in articles (for

example, converting regular quotes to smart quotes) are also included. Finally, WordPress has a rich plugin architecture which allows users and developers to extend its functionality beyond the features that come as part of the base install.

Positives:

- Simple install
- Many themes available
- Easily customizable
- Very stable
- Quickly ready for production
- Built-in image and media handling
- Popularity ensures third-party support
- Free tagging approach to content classification

Negatives:

- Not ideal for the creation of community-based websites
- Extendable, but with limitations
- Questionable security
- User roles are fairly restricted
- Single generic content type

Conclusion:

WordPress is lightweight, moderately extendable and very user-friendly, but offers little in terms of community development capability.

10.7.2. Joomla!

The Joomla package consists of many different parts, which allow modular extensions and integrations to be made easily. For instance, “Plugins” are background extensions that extend Joomla with new functionality. There are over 3,500 extensions for Joomla available via the Extensions Directory.

In addition to Plugins, more comprehensive extensions are available. "Components" allow webmasters to perform such tasks as build a community by expanding user features, backup a website, translate content and create URLs that are more friendly to search engines. "Modules" perform such tasks as displaying a calendar or allowing custom code like Google AdSense to be inserted within the base Joomla code.

Joomla permits administrators to set global configuration parameters that affect every article. Every page conforms to these parameters by default, but a page can have its own setting for each parameter. For example, you can elect to show or hide the article author or simply go with the global "show author" parameter.

Positives:

- Easy learning curve, good for novices in CMS development
- Intuitive administration user interface
- Commercial modules have a professional look-and-feel
- Community Builder module offers comprehensive features

Negatives:

- Extendable, but with limitations
- No user groups and permissions
- Most of the usefull modules are not free
- Limited, hierarchical approach to content classification

- Not all modules interface well with the Community Builder module

Conclusion:

Joomla! is a good CMS package which allows novice users to design and develop a full-featured website within a day. The limiting approach to content classification is detrimental to flexibility and the lack of user groups and permissions limits the Community Builder module.

10.7.3. Drupal

The standard release of Drupal, known as "Drupal core", contains basic features common to most CMSs. These include the ability to register and maintain individual user accounts, administration menus, RSS-feeds, customizable layout, flexible account privileges, logging, a blogging system, an Internet forum, and options to create an interactive community website.

Drupal was also designed to allow new features and custom behavior to be added by third parties. For this reason, Drupal is sometimes described as a "Content Management Framework". Although Drupal offers a sophisticated programming interface for developers, no programming skills are required for basic web site installation and administration.

Positives:

- Flexible framework for the development of web-based applications
- Vibrant developer community on the Drupal site
- New content types are easily created and may be extended with the Content Construction Kit module
- Fully customizable user permissions
- The Organic Groups module provides unrivaled community building functions
- Dynamic approach to content handling

- The Taxonomy module is unparalleled in the CMS landscape and allows for predefined content classification, as well as free tagging
- The Views module allows for custom views of any content within the content pool

Negatives:

- Limited availability of themes
- Steeper learning curve than many other CMS packages

Conclusion:

Despite Drupal's steep learning curve, it creates a framework the offers extendibility far beyond most other CMS packages. It is however supported by a vibrant and helpful community of knowledgeable developers and users. Several comprehensive pieces of literature on Drupal development also exist to help novice users.

Drupal includes a number of features and extensions (Taxonomy, Organic Groups, Content Construction Kit, Views) that allow developers to create highly customized web-based community platforms.