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Design and Development of an Academic Portal

HEILA PIENAAR
Academic Information Service, University of Pretoria, South Africa

A Web portal can be defined as a Web site for a specific audience that aggregates an array of content and provides a variety of services including search engines, directories, news, e-mail and chat rooms. This article investigates the factors that must be considered during the design and development of an academic portal. Personal interviews were conducted with academics in order to identify the content, functions, appearance and value of an academic portal. A working academic portal, the *Infoportal*, was developed to support academics' task performance.

Introduction

The introduction of the portal concept to the Web has opened new possibilities to address some of the issues concerning the personal management of academic information and knowledge. Some of the main issues are the lack of integration, personalisation and customisation of existing academic information sources and systems.

A Web portal can be defined as a Web site that aggregates an array of content and provides a variety of services including search engines, directories, news, e-mail and chat rooms. Portals have evolved to provide a customised gateway to Web information. A high level of personalisation and customisation is possible (Melzer 1999; Boye 1999). It was felt that the portal concept could be further developed to function as a sophisticated Web interface that can support the task performance (teaching and research) of academics.

Statement of the problem

The central research problem is to ascertain what factors should be taken into account during the design and development of a Web portal for academics. The central research problem can be further addressed by asking the following questions:

- What can be seen as the personal management of academic knowledge and information? What is the impact of the Internet on the scientific knowledge cycle?
- To what extent can the concept and functionality of Web portals support the personal management of knowledge and information of academics?
- What information sources, services and tools must be part of such a portal?
- How acceptable is the idea of such a Web portal for academics and what problems do they anticipate with regard to the implementation of the portal?
- Do the needs of academics who are research achievers, differ from the needs of those regarded as education achievers?
- What are the implications of this study for the design and development of a Web portal for academics and can guidelines be developed for the design and development of such a portal? Can an academic portal be successfully developed and implemented?

Theoretical background

Personal knowledge management

The scientific knowledge cycle consists of the following sectors: a user sector (literature survey, assimilation and formulation of hypotheses), a generation sector (experimental test and development of new theory), a communication sector

Dr Heila Pienaar is strategic innovation manager at the Academic Information Service, University of Pretoria, Pretoria 0002, South Africa. E-mail: heila.pienaar@ais.up.ac.za; URL: http://hagar.up.ac.za/catts/learner/heilap/personalhomepage.html

(oral reports at meetings, writing of reports and papers, primary, secondary and tertiary publication) and a storage sector (acquisition and processing for retrieval, world's storage of knowledge in libraries, archives etc.). The academic can be seen as both the user en producer of scientific information (Blom 1980). The possible influence of the Internet on the cycle of scientific knowledge can be illustrated as follows (see Table 1):

Table 1: Possible influence of the Internet on the scientific knowledge cycle

Cycle	Possible influence of Internet / Web
User sector	Sophisticated web search engines are available for end users. Traditional databases are made available on the Web.
Generation sector	Knowledge products can be created by Web editors and published on the Web.
Communication sector	Internet communication instruments, i.e. chat rooms, bulletin boards, list servers and e-mail, support ease of international contact and the creation of virtual communities. Traditional publications (journals, books, dissertations) are published on the Web. Education material is delivered via the Web (e-education).
Storage sector	Scientific information and knowledge are stored electronically and made available on the Web. Digital libraries are developed to manage the scientific information on the Web.

The academic's task performance (research and teaching) must be used as the basis for the design of an appropriate academic information system. The personal management of academic information and knowledge can be seen as an essential part of the academic's task performance. Studies of how individuals organize their work, and also of the general nature of scientific information processing work can be relevant when designing a personal information system (Moon 1988). A personal information and knowledge management model (see Figure 1) for academics was developed by using the well-known input-output model, Heek's elements of research and the Newell and Simon information-processing model (Pienaar 1991).

This model must be seen within the framework of the cycle of scientific knowledge (see Table 1). A personal information system that supports the academic's personal knowledge management must meet the following requirements (Pienaar 2001):

Figure 1: Personal Knowledge Management Model

- *Personal knowledge management*: The academic must be able to manage all his information and knowledge in an integrated manner with the aid of a seamless electronic environment.
- *Collection and retrieval of information*: The information system must support the academic's unique way of searching electronic information.
- *Personal organizing and processing of information*: The information system must provide for the personal indexing of a variety of information sources, for example literature, internal organizational information and personal information.
- *Creation, communication and distribution of knowledge products*: The creation and distribution of knowledge products (articles, reports, lectures) must be supported. Informal personal academic communication and networks must also be supported.

The use of Web portals to support the personal knowledge management of academics

There were many ideas and projects to support the task performance of academics before the arrival of the Internet and the World Wide Web. In 1945 Vannevar Bush published his famous article "As we may think". His description of the memex seems very familiar,

> Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and to coin one at random, "memex" will do. A memex is a device in which an individual stores his books, records, and communications, and which is mechanized so that it may be consulted with

> exceeding speed and flexibility. It is an enlarged intimate supplement to his memory. (Bush 1945)

During the 1980s several projects were launched in the United States of America (USA) that focused on the development of information systems to support academics. A scholar's workstation project was initiated by the Massachusetts Institute for Technology, Carnegie Mellon University and Brown University and the National Library of Medicine launched the IAIMS (Integrated Academic Information Management System) project (Pienaar 1990).

The Internet became more available as a research and communication aid during the late 1980's. In 1991 the first World Wide Web (WWW or Web) navigators were introduced and in 1994 search engines were developed to retrieve Web information more effectively. The most significant Web development of 1998 was the evolution of search engines into portals, and the parallel emergence of the Enterprise Information Portal (EIP) has undoubtedly been the most significant development of 1999 (Melzer 1999). At this stage the following portal types can be distinguished:

- *Vertical* (VEPs or Vertical Enterprise Portals or Vortals). These portals are developed for specific interest groups, for example *CNET.com* (shopping mall), *animalhouse.com* (college), *pets.com* (pets), and *women.com* (women's issues).
- *Horizontal* or MegaPortals for general use. Examples are *Excite*, *Yahoo*, *AltaVista*, *AOL.com*, and *Infoseek*.
- *Intranet or Enterprise portals*. Features that most of the vendors offer are the ability for the organizational user to customize the information they receive and the way in which it is displayed on the screen, the categorization of this information, and the integration of information from multiple databases and file formats. Many vendors also facilitate collaborative working, and provide a range of content creation and publishing options. Examples of vendors are *Business Objects*, *Plumtree*, and *Epicentric*.
- *Internet gateways or libraries* – not focused on internal enterprise functions (Strauss 2000)

The Gartner group distinguishes four levels of portal functionality:

- *Intranet entry point* – universal information, miscellaneous content, search function and links.
- *Content integration* – previous plus extensive information, advanced search, directories, and personalisation.
- *Workplace integration* – previous plus customer support, transactions, collaboration, role-based profiles, and ERP (enterprise resource planning) integration.
- *Marketplace integration* – previous plus procurement, supply chain management, e-marketplace integration, advanced personalisation, e.g. *EDI*, *XML*, and *Java* (Strauss 2000).

In May 2000 a Web indexing workshop in the Netherlands decided to start an academic portal initiative in Europe. Main components will be: indexing and searching tools; cross-searching automatic indexes and human-made subject gateways; directory services; video-on-demand and streaming (Web Indexing Workshop 2000).

The purpose of Campbell's white paper (Campbell 2000) on the scholar's portal is to suggest that the Association of Research Libraries (ARL) should seriously pursue the feasibility of developing a "library.org" Web presence. His paper refers to the proposed Web presence as the "scholars' portal". Increasingly the world's business, including the business of research, is becoming Web based. Those agencies that wish to survive are busily developing new Web architectures and exploring how to migrate significant portions of their business to the Web environment. In the academic community, this move to the Web includes internal administrative business functions and increasingly the core functions of teaching and learning. Similarly, in the research library environment, integrated systems and digital library experiments have migrated to Web based functions almost totally. The scholar's portal would promote the development of and provide access to the highest quality content on the Web. With the growing use of asynchronous learning methodologies, there is also an increasing need for extending certain elements of traditional library public services to the Web. This is already beginning to happen through experiments with virtual reference environments.

A primary function of the scholar's portal would be to provide researchers with an alternative means of retrieving dependable information beyond the capacity of commercial Web sites. Its goal would be to provide highly focused search engines adapted to the technical languages of the various academic specialities. By customizing search engines in this fashion and directing them to dependable sources of information, the schol-

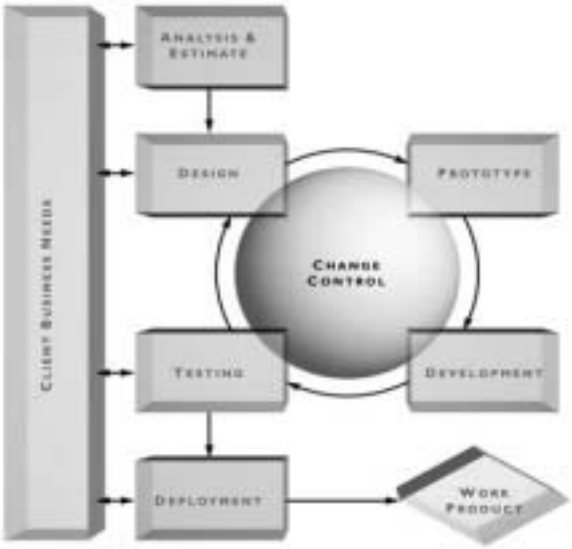
ar's portal would evolve increasingly "intelligent" automated systems and improve the success rate of query systems (Campbell 2000). An ARL Scholars Portal Working Group was set up in 2000 to explore how best to establish a collaborative research library presence on the Web. The Scholars Portal Project was launched in collaboration with a digital library software vendor in order to provide users with a single point of Web access that can reach a full array of diverse, high-quality information resources and deliver material directly to the user's desktop (Quint 2002).

The objective of the Shell Exploration and Production (E&P) One portal is to connect staff not only with everything they need, but with everyone they need, and provide all the tools they need to work together: groupware, e-mail, workflow and desktop applications must all be accessible through the portal. The Shell E&P global library took the lead with the development of taxonomies, search and content. A global search service was developed and integrated with the portal: the indexes of Shell global document management system, Shell discussion forums, the Shell Intranet and third party information services will be integrated. The library developed an exploration and production taxonomy and thesaurus and the portal will provide single sign-on access to electronic resources (Heye & Van Schagen 2002).

The Joint Information Systems Committee (JISC) is funded to promote and disseminate best practices in the field of information and communication technologies across the field of higher and further education in the United Kingdom. JISC developed the concept of seamless and integrated access to a wide range of digital collections and resources (content) through a single interface (portal) to address the problems that users experience with different interfaces to digital collections. Three different portals are under development:

- Data format portals: geospatial data and image data. Project Xgrain is a portal for searching bibliographic abstracting and indexing databases
- Subject portals: the project will produce an open source portal framework built in Java and a series of "portlets" that will provide services
- User community portals: learning and teaching portal for users in the higher education sector (Awre 2002)

Figure 2: Rapid Application Design and Development

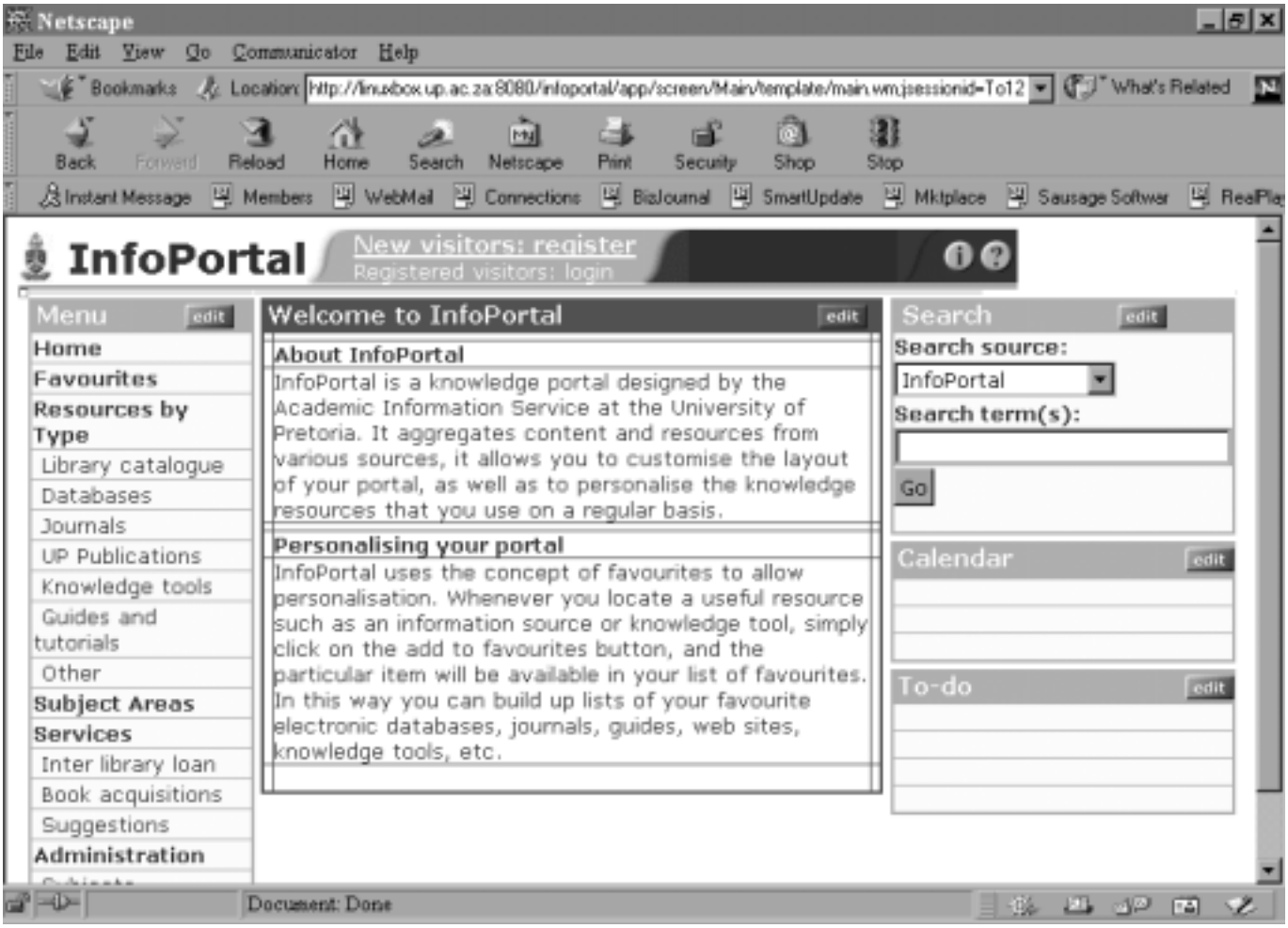


From this discussion it seems as if the concept and functionality of Web portals can be used to support the personal management of academic information and knowledge.

Research design

The most important research designs available to empirical research are the *experiment*, the *quasi-experiment*, the *survey* and the *case study* (Boshoff 1988). The case study was chosen as the overarching research design for this study, as it can be regarded as the most appropriate research design to answer the research questions. Case study research involves the study of natural cases. The use of this research design does not exclude the use of other research designs "... embedded designs are possible: for example where a survey is used to provide information about a single case selected for study ..." (Hammersley 1992). The case study approach for this study is combined with selected aspects of quasi-experimental design, participatory action research and the design and development process (Dunette 1983; Dick 1997). The traditional design and development process consists of the following phases: *analysis*, *design*, *development*, *implementation* and *evaluation*. Rapid application design and development (RADD) include the user from the start and use prototypes to speed up the process. This modified design and development model can be illustrated as follows (see Figure 2; Pienaar 2001):

Figure 3: Prototype academic portal



A combined research design was developed in order to answer the research questions (Pienaar 2001). Two groups were identified:

- Group A: A purposeful sample of five academic achievers at the University of Pretoria (case studies).
- Group B: A purposeful sample of five education innovators at the University of Pretoria (case studies).

During August to September 2000 interviews were conducted with eight senior academics (four academic achievers and four education innovators) at the University of Pretoria, South Africa. They are experts in the following subject fields: Zoology, Engineering, Accounting, Biology, Languages, Psychology, Physics and Archaeology. An interview schedule was used and interviews followed the following structure:

- Collection of the respondents' demographic information: sex, age, Web literacy, and percentage time spent on research and teaching.
- Identification of the academics' information needs using the personal knowledge management model as framework (see Figure 1).
- A prototype academic portal was developed (see Figure 3). The academics were asked to work through this portal on the Web. Their activities and comments were recorded.
- The academics evaluated the prototype portal formally according to the interview schedule.

A focus group interview with fifteen information specialists or subject librarians was also conducted on 5 October 2000 in order to obtain their views on the feasibility of the portal concept and to support data triangulation.

Identification of the academics' information needs

The personal knowledge management model includes these aspects: collection and retrieval of information, organising and processing of informa-

tion, the creation of knowledge products and the communication and distribution of knowledge (see Figure 1). The following questions were put to the academics:

- Collection and retrieval of information
  - What information sources do you use? What are the frequency of use and availability on the Web of these information sources?
  - What information services do you use and frequency of use?
- Processing of information and the creation of knowledge products
  - What technological tools do you use for the processing of information and the creation of knowledge products (for example lectures, papers and articles)?
- Communication and distribution of knowledge
  - How do you communicate your knowledge products?
  - How do you communicate with your invisible college of scientific colleagues?
- Personal knowledge management
  - Do you experience any problems with regard to your personal management of information and knowledge?

Evaluating the prototype portal

A prototype Web portal was developed by a software company, Opticode Software. The Web address (URL) of the prototype portal was given to the academics and they had to access and use it on the Web. Their reactions and problems were recorded by the researcher. After this exercise they were asked specific questions about the acceptability of the portal concept, the information sources, functions and the look and feel of the portal.

Research results

Some general results from the interviews:

- The computer literacy level of these academics is medium to high.
- Their Internet / Web literacy level is low to medium.
- Research is the main activity of this senior group, although teaching is also seen as an important activity.
- The Internet / Web is not well integrated in research and educational processes. They are mostly using e-mail and Web search engines.
- The university library's Web products are not well known.
- There are no significant differences between the research achievers and the education innovators in terms of portal requirements.
- These academics are very positive about the portal concept to support their personal management of academic information and knowledge.

Guidelines for the design and development of a Web portal for academics

Guidelines for the design and development of a Web portal for academics are formulated against the background of the theoretical study and the empirical research results discussed in this article. The personal knowledge management model (see Figure 1) is used as a framework for these guidelines.

Personal management of academic information and knowledge

In order to support academics' personal knowledge management in an integrated manner the academic portal must have the following characteristics:

- The type of portal is a combination of a vertical portal (vortal) and a corporate or enterprise information portal.
- High levels of functionality and integration are needed – a seamless interface. This must include advanced personalisation and customisation capabilities.
- The portal must support both the teaching and research roles of academics.

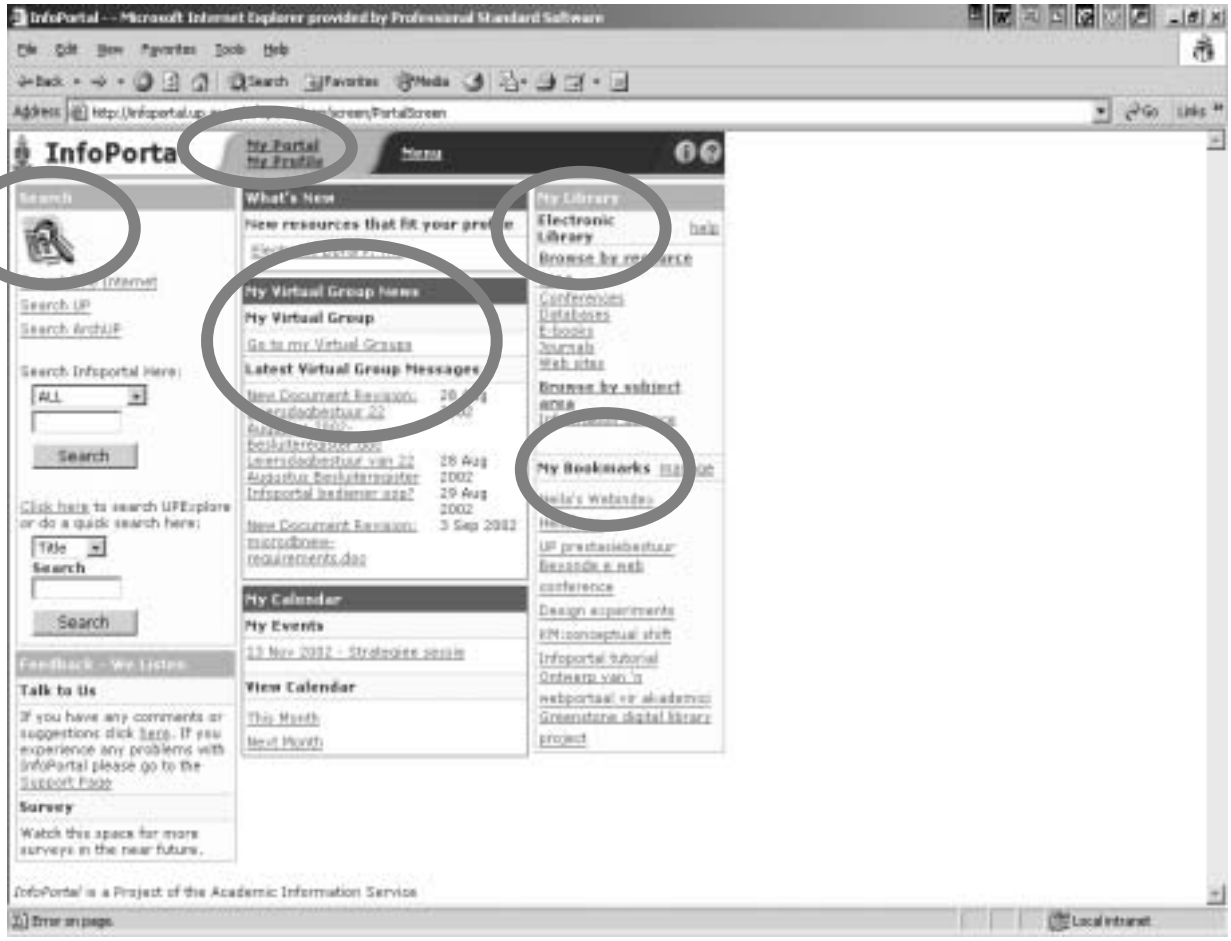
Personal collection and retrieval of information

- The portal should give access to the following *information sources*: e-journals, e-articles, e-reserves, e-archives, databases, e-books, e-dissertations, library catalogues, and the university's research database. Personal information sources should also be available, for example experts and information specialists.
- The following *functions* are needed: Web search engines, global search function, list servers, chat rooms, e-mail, adding of URLs, interface with document delivery and inter library loan systems. Academics should be able to evaluate and add information sources to the portal.

Processing of information and the creation of knowledge products

To support these aspects the portal must make indexing tools available. Microsoft tools are also essential. The portal must also support e-publishing.

Figure 4: Infoportal



Communication and distribution of knowledge and knowledge products

The following communication modes must be accommodated:

- Virtual conferences must be supported.
- Web teaching must be possible: virtual classrooms, demonstrations and lectures.
- Workspaces for research projects must be available.

Development of the Infoportal

Infoportal functions or applications

A working academic portal, called *Infoportal* (see Figure 4), was developed by Opticode Software to accommodate these findings and guidelines.

Some of the *Infoportal's* functions are shown in Figure 4: customisation and personalisation (my portal (see Figure 5) & my profile (see Figure 6); search function for the Internet, Intranet and *Infoportal*; virtual group function for online academic collaboration; selective dissemination of information function (what's new); Web resources (resource type and subject area) and a personal bookmark function.

The three most popular functions or applications of the *Infoportal* at this stage are the electronic library function, the virtual group function and the micro database function. The electronic library function enables users to browse the electronic resources by type (conferences, databases, e-books, journals and Web sites) and by subject area (the different academic departments) or the topic (e.g. ostrich). The information specialist is responsible for keeping the content up to date and academics can also take part in this process. New or changed electronic information sources need only to be updated once and the electronic resources for a specific subject are grouped together (see Figure 7).

Figure 5: Customisation (My Portal)

Figure 6: Personalisation (My Profile)

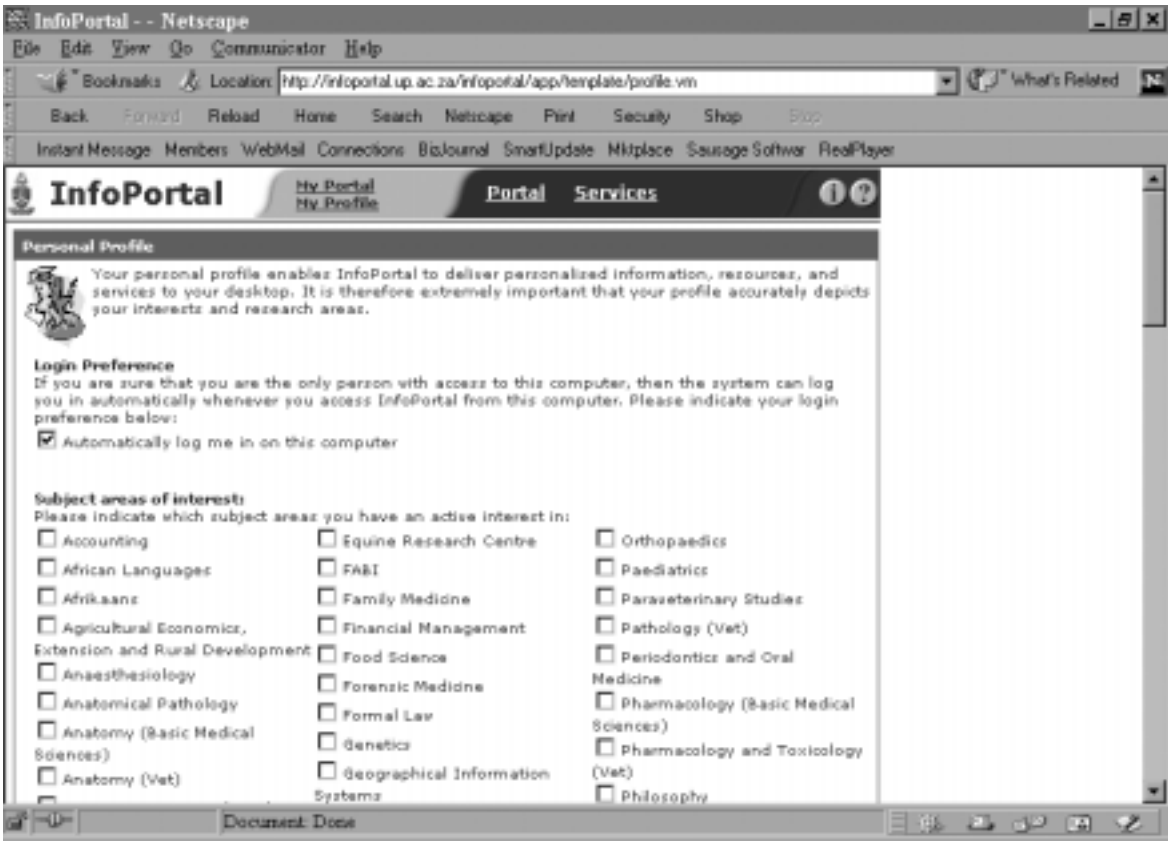
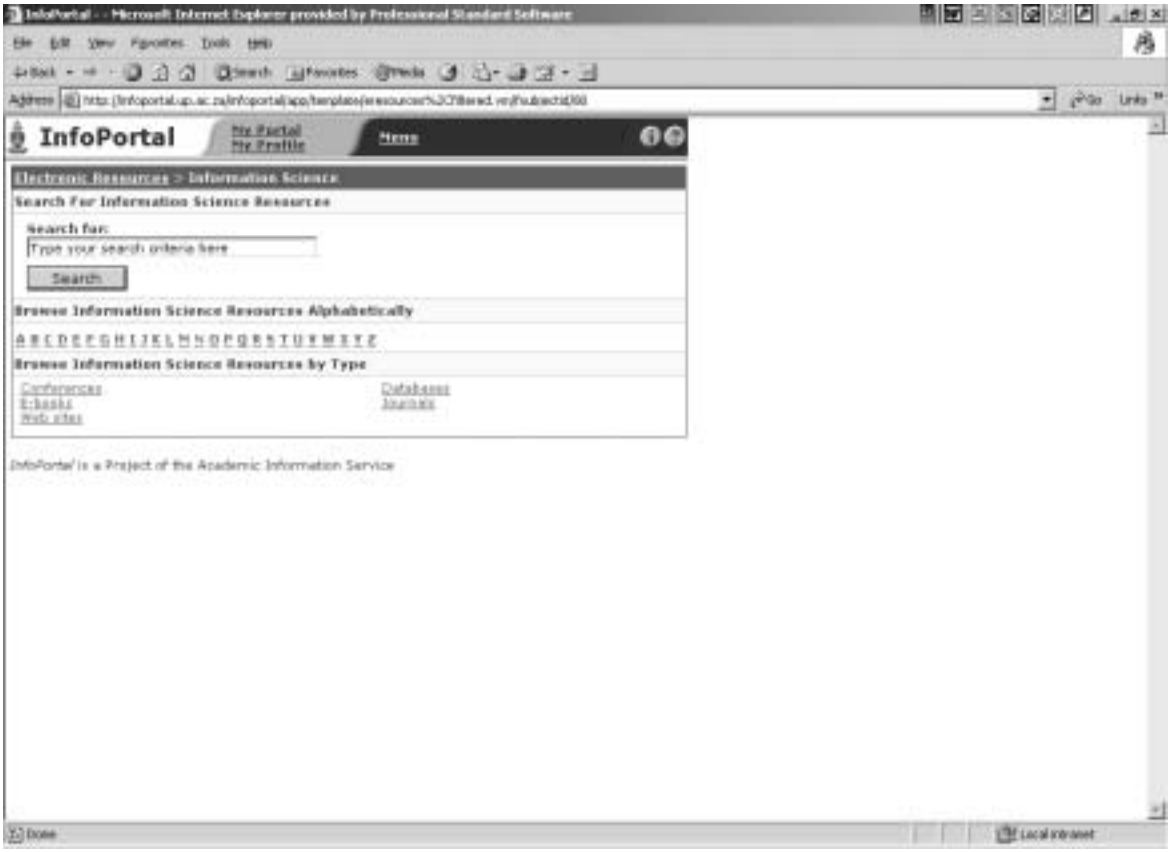


Figure 7: Electronic resources for Information Science



The virtual group function is used by academics and information specialists to facilitate and support academic communities of practice (COPs) or knowledge networks. It is possible to send e-mail messages via the *Infoportal*, to upload any documents, to add bookmarks and to schedule meetings with the aid of this function (see Figure 8). This information is only available for members of a specific group.

The micro database function enables the academic user or department to index academic bibliographic information and to make it available on the Web (see Figure 9).

Infoportal architecture

Several strategic decisions regarding the overall technical architecture of the portal was made to best fit the requirements:

- *Java* was chosen as primary development environment to facilitate rapid development and maximize interoperability with existing systems.
- Several components from high quality open source projects were selected as building blocks for the portal architecture. Some of the more prominent projects include *Apache Turbine*, a Web application framework, and *Apache Xerces*, an *XML* parser.
- To further improve interoperability and extensibility, *XML* was used throughout the portal for data interchange and information encoding (see Figure 5; Pienaar & Conradie 2001).

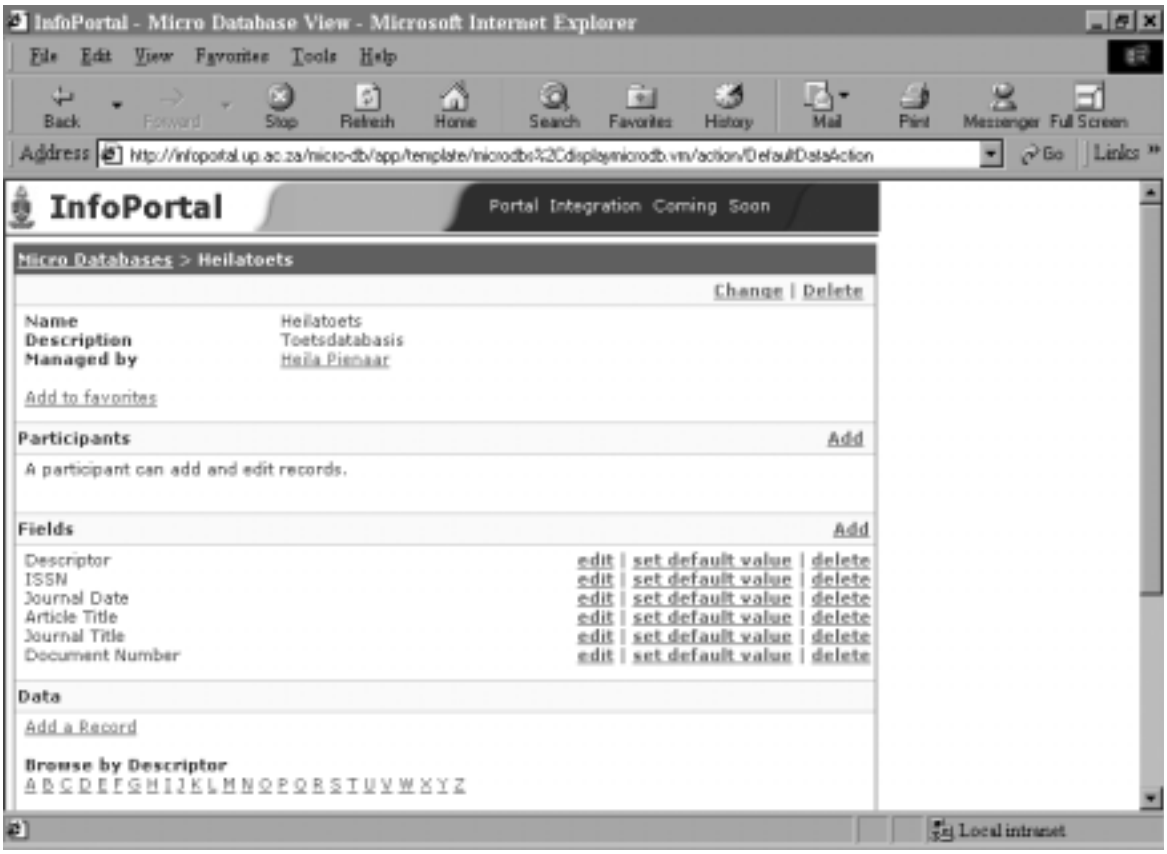
Implementation and evaluation of the Infoportal

The *Infoportal* was launched in March 2003 with training sessions for information specialists and the academic community of the University of Pretoria. An online tutorial was created to facilitate the use of the *Infoportal*. The reaction of users to the portal is very positive. Formal evaluation of the use and feasibility of the portal will take place by the end of 2003.

One of the most important benefits of this portal development is the decision by the information technology (IT) department of the university to accept the portal architecture as the official IT architecture of the campus. The portal architec-

Figure 8: Virtual Group function

Figure 9: Micro database function



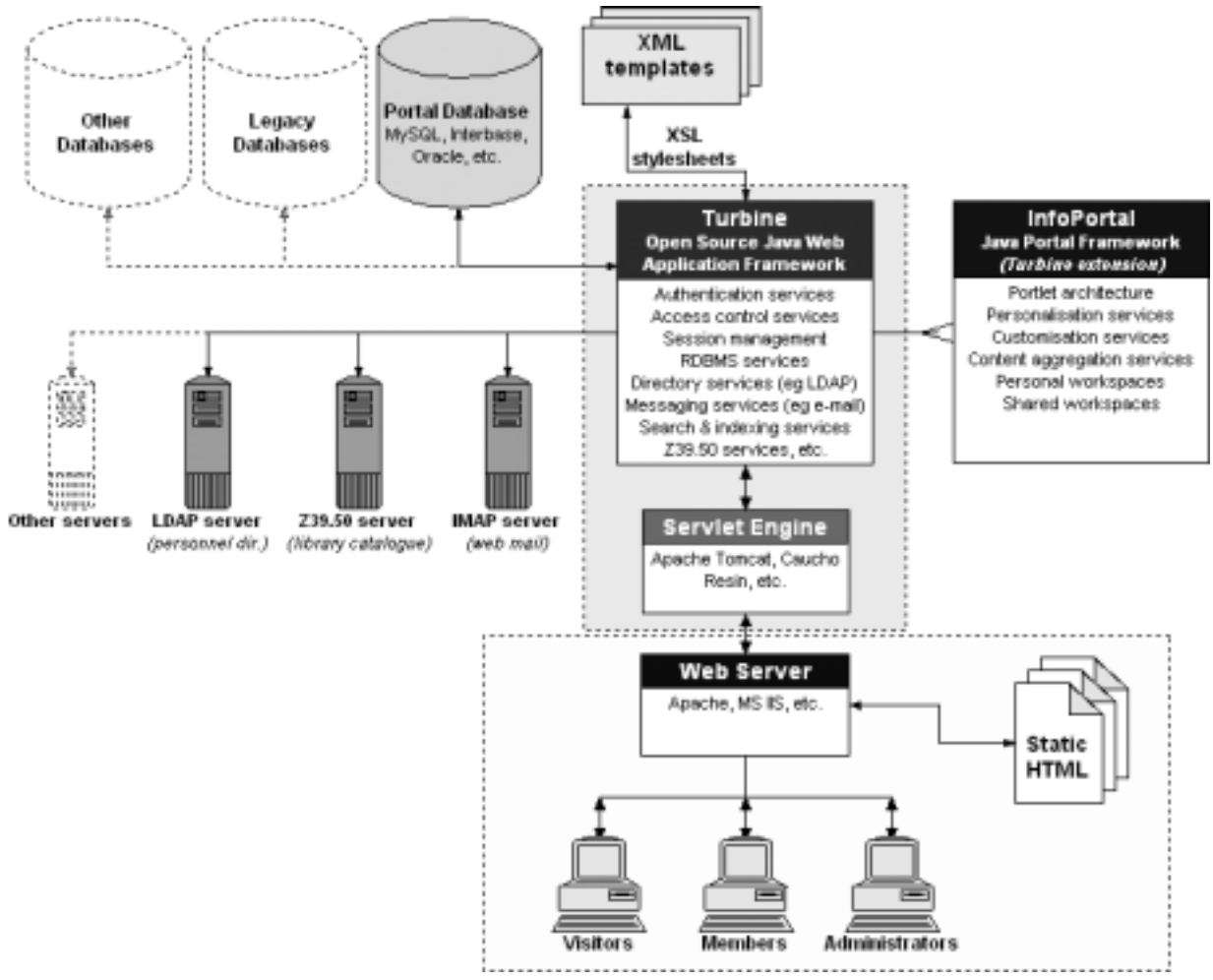
ture (see Figure 10) was redeveloped and different configurations are possible, for example the *Infoportal* for academics and an Intranet portal for administration.

New *Infoportal* functions are developed continuously. At this stage the Greenstone open source software for the building and retrieval of digital collections is under investigation (Witten, Bainbridge & Boddie 2001). An academic knowledge sharing system is also envisaged. Library services, for example an improved online inter library service in consultation with Sabinet Online (URL: http://www.sabinet.co.za/) are also planned.

Conclusion

This article examines the possibility of using the concept of a Web portal to support the academic's task performance. The central research question is to ascertain what factors should be taken into account during the design and development of an academic portal. A model (see Figure 1) was identified as a conceptual framework for the study. During the interviews this model was validated as a sufficient framework to explain the personal management of academic information and knowledge. The current knowledge management practices (collection, retrieval, organising, processing, creating, communicating and distributing academic information and knowledge) of these academics were investigated. The results give an indication of the different academic practices that should be supported by an academic portal. Although the Internet and the Web have the potential to make a huge impact on academics' task performance, in practice the impact has been limited and these academics' Web literacy was actually quite low. These aspects have to be taken into account during the design and development of the academic portal. The concept and functionality of the prototype academic portal were acceptable to these academics and it was

Figure 10: Portal architecture



possible to develop guidelines for the development of an academic portal. The *Infoportal* was developed to accommodate these guidelines. The reaction to the *Infoportal* is very favourable and the launch took place in March 2003.

References

Awre, C. 2002. Portals as gatekeepers to content within higher and further education. *26th Online information 2002 conference proceedings*, London, United Kingdom, 3–5 December 2002.

Blom, A. 1980. *'n Teoretiese model vir die bestudering van die inligtingbehoeftes van wetenskaplikes* (A theoretical model of the information needs of scientists). Johannesburg: Rand Afrikaans University. (D Phil dissertation)

Boshoff, AB. 1988. Navorsingsmetodiek in toegepaste geesteswetenskaplike navorsing (Research methodology in applied humanities research). *South African journal for library and information science* 56:1–6.

Boye, J. 1999. Are all portals the same? *Internet related technologies*. URL: http://tech.irt.org/articles/js147/ [viewed October 2, 2002]

Bush, V. 1945. As we may think. *The Atlantic monthly* 176(1): 101–108. URL: http://www.theatlantic.com/unbound/flashbks/computer/bushf.htm [viewed October 2, 2002]

Campbell, J.D. 2000. The case for creating a scholars portal to the Web. A white paper. *Association of research libraries proceedings of the 136th annual meeting*, Baltimore, Maryland, May 17–19. URL: http://www.arl.org/arl/proceedings/136/portal.html [viewed October 2, 2002]

Dick, B. 1977. A beginner's guide to action research. URL: http://www.scu.edu.au/schools/sawd/arr/guide.html [viewed October 2, 2002]

Dunnette, MD. (editor) 1983. *Handbook of industrial and organizational psychology*. New York: Wiley.

Hammersley, M. 1992. *What's wrong with ethnography?* London: Routledge.

Heye, D., Van Schagen, E. 2002. Portals are the future for libraries: the implementation of the Shell EP One portal and the role of the Shell Global EP Library. *26th Online information 2002 conference proceedings*, London, United Kingdom, 3–5 December 2002.

Melzer, C. 1999. Enterprise information portals. *South African journal of information management*, 1(2/3):1 URL: http://general.rau.ac.za/infosci/raujournal/vol1.nr2.01_09_99/default.asp?to=webs [viewed October 3, 2002]

Moon, C. 1988. Computerized personal information systems for research scientists. *International journal of information management* 8: 265–273.

Pienaar, H. 1990. *Die geïntegreerde persoonlik akademiese inligtingstelsel – 'n verkennende studie* (The integrated personal academic information system – an exploratory study). Pretoria: University of Pretoria. (M. Bibl. thesis).

Pienaar, H. 1991. *Geïntegreerde persoonlike akademiese inligtingstelsel: 'n verkennende studie* (The integrated personal academic information system – an exploratory study). *South African journal for library and information science* 59:10–18.

Pienaar, H. 2001. *Die ontwerp van 'n Webportaal vir akademici* (Design of a Web portal for academics). Pretoria: University of Pretoria. (MEd (Computer-assisted Education) thesis). URLs: http://hagar.up.ac.za/catts/learner/heilap/skripsie.html; http://upetd.up.ac.za/thesis/available/etd-05312002-124329/ [viewed October 3, 2002]

Pienaar, H., Conradie, F. 2001. Design and development of a portal for academics. *6th Southern African online information meeting, Kempton Park, South Africa, 19–21 June 2001*. URL: http://hagar.up.ac.za/catts/learner/heilap/portaalakademicilesing.ppt [viewed October 3, 2002]

Quint, B. 2002. Academic libraries develop integrated portal software package. *Information today. Newsbreaks and conference reports*. URL: http://www.infotoday.com/newsbreaks/nb020513-2.htm [viewed October 3, 2002]

Strauss, H. 2000. What is a portal, anyway? *Tech talk event* URL: http://www.cren.net/know/techtalk/events/portals.html [viewed October 3, 2002]

Web indexing workshop (Notes from the panel at DESIRE II), 2000. Building community oriented portals: Academic portal solutions and REIS initiative. May 14, 2000, DelfTU library, Delft URL: http://www.terena.nl/d2-workshop/d2webindex2000/d2webindex-tapnotes.html [viewed October 3, 2002]

Witten, I.H.; Bainbridge, D.; Boddie, J. 2001. Greenstone open-source digital library software. *D-Lib Magazine* 7(10) URL: http://www.dlib.org/dlib/october01/witten/10witten.html [viewed October 3, 2002]

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