Information Interoperability And Organization For National And Global Forest Information Systems: Conference Overview

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In a digitally networked age, the ability to connect systems, databases and information-rich environments becomes more possible but also more problematic. The goal of seamless, transparent, and 'user-friendly' information access makes interoperability a required attribute of databases, systems, and vocabularies. To address this issue, a IUFRO conference "Information Interoperability And Organization For National And Global Forest Information Systems" was held September 17-19, 2003 as a side event of the XII World Forestry Congress in Quebec City. The conference brought together international scientists, practitioners, information professionals and administrators to discuss the technical and human dimensions of efforts to enhance interoperability within regional, national and global forest information systems.

Miller's description of Interoperability, "[Interoperability ensures] that systems, procedures and culture of an organization are managed in such a way as to maximize opportunities for exchange and re-use of information whether internally or externally,"[5] implies that human and organizational issues are as important as computer-related issues in ensuring Interoperability. This was reflected in the session structure of the conference, with a session on "The Human Factor" (moderator Carol Green) following the preceding sessions "Foundations and Fundamentals" (moderators Robin Quenet and Brian Low), and "Systems and Applications" (moderators Alois Kempf and Roger Mills).

Foundations and Fundamentals

Ron Lake, CEO of Galdos Systems Inc, speaking on behalf of the Open GIS Consortium (OGC), gave the keynote presentation for the "Foundations and Fundamentals" session. The OpenGIS Consortium is an international standards organization focused on making spatial data and services ubiquitous. His presentation was based on a more systems-oriented definition of Interoperability: "The ability of systems to provide services to and accept services from other systems, and use the services so exchanged to enable them to operate effectively together." Implicit in this definition was the concept that people have different world views and different vocabularies, and a means was required to ensure that messages get delivered.

Interoperable systems were described as interacting systems that were connected such that they could exchange messages that were meaningful to both the sender and receiver. In the exchange, the sender and receiver could determine each other's worldview and vocabulary. The sender's messages cause predictable responses at the receiver and the receiver's responses are messages back to the sender.

Ron used Forest Information Systems (FIS) as the basis of his subsequent examples. FIS are interacting systems for acquisition, processing, distribution and analysis of information about forested lands and are characterized by being geographically distributed, in different jurisdictions, with dynamic information and many different interests involved. These geographically distributed systems use web services to send a message and get a response. In this process, a FIS has first to find a service, and then

[5] Miller, P. 2000. "Interoperability. What is it and Why should I want it?" 21-Jun-2000 Ariadne, Issue 24 http://www.ariadne.ac.uk/issue24/interoperability/ (accessed October 18, 2002.)

find out how to send that service a message. It must construct the message, send it, get a response and process it. Geo-spatial Web Services are used in this process.

In these Service-Based Architectures, a client application sends a standardized request message to a service provider, which returns a standardized response message, and may provide access to data. In the process, services can roll-up data from multiple sources, often by being chained together, and standard interfaces permit ease of access.

This is accomplished by having a standard language to encode the messages, such as the OGC Geography Markup Language (GML); standard and discoverable interfaces for the web services, such as OGC Web Services & W3C Web Service Description Language; and a registry service to manage the service descriptions and the message encodings, such as the OGC Web Registry Service.

GML is an XML language for describing and transporting geographic information, and for describing geographic types for web service interfaces. It provides a set of schema components or primitives, and a set of rules for building components such as application specific geographic features, coverages and observations. The GML is composed of building blocks that include features and styles. For successful FIS, we need to develop a national vocabulary (vocabularies) and schemas.

Web services work by sending messages over the Internet, and by using standard discoverable interfaces, the replies can define the properties of other systems. In the OGC Web Feature Service, a request specifies elements such as area of the world, feature type names or properties, and return format. The response is a set of geographic features, in GML but possibly also including vendor specific formats. In this process, the W3C Web Service Description is used to provide information on available services, using the Web Service Description Language (WSDL). Service Registries maintain information about the kinds of services available, and rely on standard protocols and encodings.
To discover services there is a standard request protocol for discovering services based on Service Instance Metadata contained in Service Registries. The foundations of the systems are therefore a language for messages, descriptions of services, and a method of finding them, with access control using a grammar defined by the provider.

Many of these features were illustrated by Binh Nguyen Thanh of IUFRO in "GFIS- Global Forest Information Systems- A prototype for managing forest information resources", IUFRO's own system. The paper is given in full elsewhere in these proceedings. GFIS is a tool for managing forest information resources. It integrates new IT issues such as Web Technology, metadata and standardization, RDF, XML, data integration and repository, interoperability search, and a decision supporting system with a Data Warehouses and OLAP. GFIS metadata is based on the Dublin Core metadata standard.

When government, NGO and private sector agencies cooperate in the delivery of national forest information on the Web, participation in must have a low overhead and member agencies must retain autonomy of business practice and technology. This can be ensured through use of "A Distributed Access Control System (DACS) for Secure Delivery of Web Services in a Federated Organization", as described in a presentation by Rick Morrison of the Canadian Forest Service, co-authored by Barry Brachman and Brian Low. DACS supports authentication, single-sign-on and access control, based on the concept of a Jurisdiction, which can be an organization, department, lab or workstation. A Jurisdiction authenticates its users using its existing mechanisms, and if authentication is successful, DACS creates encrypted credentials to identify a user and accompany subsequent service requests. The DACS framework allows users to access resources at different jurisdictional nodes without having to re-authenticate, and leaves access control decisions under jurisdictional authority.

Article II of the IUFRO statutes is to promote research cooperation "by working towards uniformity of nomenclature and standardization in matters such as information storage and retrieval." Barb Holder of Forintek, with Jarmo Saarikko, described one approach to this important process in "Forest Decimal Classification (FDC) update - An international community project". The project involves the international cooperation of IUFRO, FAO (UN Food and Agriculture Organization) and CABI Publishing. The initiative is significant in that the Oxford Decimal Classification (ODC)/FDC system is a useful tool for organizing electronic as well as paper resources. Features include: custom designed by forest researchers; hierarchical subject divisions; standard; international (12 languages), extensible and faceted. Different library subject classification schemes will have different pros and cons for organizing different forms of information: a physical library of printed documents; a personal physical collection of printed documents; classifying records in a reference database or a library collection database, or organizing a website or web resources. However, in a multi-lingual setting, the hierarchical numeric code of the ODC/FDC system has certain advantages. The project is linked to related projects within the forest sector such as ontologies and multilingual thesauri.

In "The COMET Architecture: An approach based on metadata to integrate forestry decision support components", Martin Döllerer of Technische Universität München described an XML-based approach to integrating components such as separate forest models to act as a single forestry decision support system.

As described elsewhere in these Proceedings, Andreas Schuck of the European Forest Institute and his colleagues discuss "Internet-based data processing and visualization – the European Forest Information System Prototype". The emphasis of EFIS is on strengthening existing national and international mechanisms for information processing and exchange to ensure effective and equitable availability of information. The objective is "to collect, co-ordinate, standardise process and disseminate information concerning the forestry sector and its development." The EFIS and GFIS systems were compared. The technical goals of EFIS were to elaborate a platform independent, effective resource discovery system for retrieving standardised metadata; to develop a system for retrieving data from distributed databases, then processing and presenting data using innovative tools while allowing diverse user groups to produce custom products facilitating processing of forest statistical data and/or Earth Observation data.

Also in this Proceedings is the full paper of "The Open Research System: A Web-based Metadata and Data Repository for Collaborative Research" presented by Charles Schweik (University of Massachusetts), co-authored by Alexander Stepanov and J. Morgan Grove. The project aimed at developing a web-based metadata sharing system and investigating Open Source\Open Content collaboration as a possible new paradigm for the production of scientific information. They found that Internet-based metadata databases are "filing cabinets" that are only successful if end-users undertake good filing habits. Longer-term projects with geographically distributed members will have higher need for Internet-based metadata filing systems, but adoption rate appears to follow an exponential curve – a "critical mass" needs to be reached. Incentives and penalties to encourage metadata submissions are critical. The Web brings new opportunities such as data use tracking systems, and the emergence of Open Content Licensing. Open Content Licensing involves a spectrum of rights, from "all rights reserved" to "public domain", and addresses four key questions: freedom to copy or distribute; ability to make derivative works; requirement for author attribution, and use in commercial applications without permission.

The session concluded with a presentation and panel discussion on "The Need to Say What You Mean and Mean What You Say" by John Helms, University of Berkeley, and colleagues. The presentation, found in full elsewhere in these proceedings, and the panel discussion, focused on the issue that multiplicity of definitions impedes the compiling of the national and international statistics that are the basis of negotiating multinational agreements. Use of Terminology Management to address the problem was discussed through the examples, "plantation", "forest health", and "sustainable forest management".

Terminology Management is the manipulation of terminological resources for specific purposes such as dictionaries, databases, finding multilingual equivalencies and creating new terms in technical writing. It is based on three key components: interoperability, harmonization, and standardization, and partitions "interoperability" to focus on "Semantic interoperability" where individual agencies and processes use different terms to describe similar concepts or even use identical terms to mean different things.

Systems and Applications

Peter Holmgren of FAO gave the second keynote address and began by defining interoperability, in wording used by the US Air Force, as the *"Ability of organizations or individuals to operate toget*her to achieve a common goal." In this view, interoperability operated on three levels: Strategic (Agreements, Partnerships, Objectives), Tactical / Operational (Who does what?), and Technological (Information systems and Standards). In forestry, however, interoperability tended to be restricted to the technological level, being reduced to 'communication protocols', possibly because the concept in the civilian world was still immature, or because managements have been slow to bring new potentials into decisions. All systems pass typically through four stages, driven by some type of market force: innovation, with many differing systems; interoperability, involving much effort to bring systems together; standardization, further reducing the number of systems; and consolidation, where the concept has fully entered the market economy and mergers/acquisitions occur, possibly leading to a single system/monopoly. Forest information systems are typically at stage 1; geographic information systems at stage 2, and the web as a whole at stage 3; Microsoft Word might be seen as an example of the fourth stage.

Interoperability is not only driven by a desire to improve systems and access, but by a desire to protect institutional effort and may have the effect of stifling innovation. As a system passes through the four stages, creativity drops, but corporate benefit rises. ICT costs are low at the innovation stage, high during the development (interoperability/standardization) stage, and lower again at the production stage; many projects therefore fail during development. But corporate benefits are the final aim and therefore interoperability IS desirable.

Standards are needed to codify consensus and thus add value; however, consensus cannot be created by standards, and the process is led by organisations that stand to benefit. So we can't stop at the interoperability stage, because market forces (or the equivalent) will make sure we move on – provided what we do is in demand.

A forestry information system is more than a GIS system or web technology. It is an important concept for democracy and governance, a concept that should provide timely, accurate, transparent and credible information for the forest sector as a whole, for a given constituency. All information should be on the web (thought it may be supported by off-line materials), and some needs to be compiled, it is not all 'out there' awaiting discovery. Time scales are long, as forests and politics change slowly. Contents are very specialised, potential user numbers are relatively low and costs relatively high. Peter illustrated these points with reference to FAO's FORIS system. A checklist of FIS requirements included: *Defined constituency; Statutes and relevance; Long-term funding; Institutional capacity and stability; Acceptance, reliance and access; Evolutionary approach.* All are needed for success, though success is not easy to measure. Interoperability will work when strategic aspects are settled, with common goals and mutual partnerships; when territorial fighting ends; when technology has left the innovation stage; and when the focus is on real content rather than metadata. Illustrating 'success factors' with a slide of the Hindenberg disaster, Peter warned that launching a good concept with the wrong technology might mean not just the failure of that project but reluctance, that could last for many years, to invest in similar projects. He concluded that we need common goals and a shared vision, true collaboration, and a focus on content, to build successful forest information systems.

Robert Magai, University of British Columbia, then presented a paper on "Designing and Implementing a Geospatial Data Warehouse in Enterprise Forestry". The full paper, co-authored by Lee Wookey is available elsewhere in these proceedings. A data warehouse was defined as a centralized relational database that stores integrated corporate data, a system that sometimes stores summary tables and supports OLAP queries, and that stores "snapshots" of data that do not change and can therefore be used for DSS queries. Such a collection of data for decision support processes is subject-oriented, integrated, non-volatile and time-variant. Two conceptual and spatial design models for forestry data warehousing are discussed, i.e. the Star Schema Model, with fact table and dimension table and the Materialized View Model, by storing a "snapshot" of the view in the database. Testing results gave evidence that the ESRI's SDE layers lost spatial configuration when materialized, that the Star schema was inadequate to represent multi-dimensional data such as GIS data and that materialized views require a lot of initial planning and set-up work. They concluded that a Hybrid model combining the Star schema and the Materialized views is adequate for forestry data warehouse operations, i.e. managing storage and querying of data.

The presentation given by Jean-Marc Frayret was on "Multi-Agent Coordination Based on Tokens: Reduction of the Bullwhip Effect in a Forest Supply Chain". The authors Thierry Moyaux, Brahim Chaib-draa and Sophie. D'Amours of Laval University, Québec, focused on "business" interoperability" in the value creation process of the forest supply chain. Not only is interoperability needed for information exchange and knowledge management, but also the way business is done within the supply chain has also to be taken into consideration. Appropriate methods, tools and standards (e.g., EDI, EDIFACT, X12, Web services) should support both business transactions and organizations in jointly making decisions (e.g., inter-organizational information systems, agent-based systems, coordination protocols, negotiation protocols, joint decision making heuristics). By doing so the bullwhip effect, which amplifies variability in the system and causes problems in supply chains with distributed and often decentralized actors, can be reduced. Otherwise companies make inappropriate decisions based on uncertain and distorted information in order to maximize their own profit. The authors recommend a structured approach to exchange and process information about demand in order to reduce inventory variations and fluctuations in distributed systems. This would be possible by a decentralized coordination mechanism based on tokens. When token-based mechanisms are applied, information gains in velocity and each company knows in real time the actual market consumption because every supplier broadcasts this information. The presented model of supply chains has been tested with The Québec Wood Supply Game.

Brian Low and his colleagues described a particular example of a Forest Information System in "Distributed Spatial Analysis Services using OpenGIS WMS". He gave an introduction to the objectives of the Open GIS Consortium (OGC), referring back to Ron Lake's presentation. Brian also described the main features of Web-enabled Mapping Services (WMS) in relation to some basic notions of geographical information systems (GIS) such as grid, cell, map layer, vector data, raster data, intersection or union. Web services are software functions available over the Internet/Web and that can respond to requests from a client; in the case of a WMS it produces maps of geo-referenced data that are being transmitted as pictures across the web. The specification defines a syntax for the WWW URL that invokes interoperable and vendor neutral operations (GetCapabilities, GetMap, GetFeatureInfo). This allows one to overcome the heterogeneity of the many proprietary applications with specific mechanisms for querying and sending requests. As an example, the Canadian National Forest

Information System (NFIS) relies on a distributed spatial analysis architecture (see also presentation by Robin Quenet) for the interaction between the user and the WMS application by means of a web browser.

A paper, "A Distributed Information System for Public Nature and Forest Management in the Walloon Region (Belgium) based on low VPN and using OpenGIS standards" by Christine Farcy, Bernard de Terwangne and Philippe Blerot was presented by Bernard de Terwangne from STAR INFORMATIC sa, and is available in full elsewhere in these proceedings. Fifty percent of forest in the Walloon (southern) region of Belgium is publicly owned and managed by the Forest and Nature Division (DNF) of the Walloon Region Ministry (MRW), organised through district offices within a four-level hierarchy. Districts had stand-alone management and GIS systems for wood production and sale. The challenge was to produce an integrated, future-proof system to improve internal communications, allow exchange of data with other parts of the MRW and external agencies. To allow interoperability between the STAR and ESRI GIS systems used in MRW within the low bandwidth constrains of the existing Virtual Private Network (VPN), the OpenGIS Web Mapping Specification (WMS) was adopted. This permits data to be maintained where collected, important both operationally and psychologically, and facilitates data and information flow across district boundaries for neighbourhood and regional planning, and for the use of external background information in local operations. Future plans include more reliance on metadata, improved analysis tools, and network upgrading to enhance online access.

Philip Herold's (University of Minnesota) presentation "AgNIC: a Model for Excellence in Distributed Partnership" showed how much can be achieved by voluntary effort by disparate organisations with a common goal. AgNIC, the Agricultural Network Information Center (www.agnic.org) is a discipline-based distributed network providing online resources for information in agriculture and related sciences including forestry. Formed in 1995 by an alliance of four land-grant universities and the National Agricultural Library (NAL) in Washington DC, AgNIC now has 29 partners plus 11 supporting organisations, and 41 unique subject-based websites. Governance is through a co-ordinating committee and executive board. It operates on consensus decision-making and a spirit of co-operation and collaboration rather than competition. AgNIC is now developing a state-of-the-art portal with web services and content management, delivering more databases, events calendar, discussion forums and current awareness services. The system allows for a high degree of collaborative management and user customization. Standards are Dublin Core metadata, NAL Thesaurus for controlled vocabulary, and web services to ensure independence of time, place and platform. AgNIC demonstrates the viability of a model based on volunteer membership, minimal investment, and partnership government. Building on existing collection strengths, its small vertical segments distribute responsibility and encourage 'ownership'.

Robin Quenet, Canadian Forest Service, presented the paper "Delivery of a Full Resolution Representation of Canada's Protected Areas using Distributed Warehouse Technology", prepared together with R. Vanderkam, B. Low and G. Howell. Responsibility for protected areas legislation in Canada rests with a variety of autonomous agencies with differing mandates, holding information using different classification schemes and data capture and storage tools on their own jurisdictional servers. To meet their conservation and business needs, and domestic and international reporting requirements, the ability to serve-up authoritative and complete representations of protected areas is a pre-requisite. This requires co-operation between individuals, organizations and systems in adopting common business practices, defined standards for data collection, metadata and searching, national schemas and interoperable information servers. The NFIS and Canadian Information System for the Environment (CISE) are working with other agencies to enable distributed access to and assembly of the required information, using the NFIS technical infrastructure as described in the earlier paper by Low. The system supports date stamping of information, archival coverages storage for time series analysis and reporting, metadata entry, custodial identity, certification, contact and acknowledgements Robin illustrated his talk with examples of compiled information meeting various requirements.

Cheryl Oakes' (Forest History Society) talk on "Do it Yourself Interoperability: Two Small Organizations Collecting International Forest History Bibliography", co-authored by Jan Oosthoek, was a good example of the many conceptual issues and formal aspects that one has to consider in an information exchange project. The cooperation between the Forest History Society (FHS) and the European Society for Environmental History (ESEH) was related to bibliographic data. The thematic collaboration made it necessary to solve problems of data fields, exchange formats, multilingual records, indexing tools, different software solutions, update procedures and quality control. The information technology framework and the allocation of specific roles to people involved have shaped the process of bibliography production, dissemination and use.

Prof. Sophie D'Amours presented the research of the FOR@C group on "Conceptual framework of a multi-agent experimental platform to evaluate supply chain management strategies in the forest products industry" done by S. D'Amours, J.M. Frayret, A. Rousseau and S. Harvey, Université Laval, Québec. By nature, supply chains are distributed network of business units, which are linked together under different types of relationships. The autonomy of most of the supply chain business units limits the potential to centrally make the different decisions. Usually each units or group of units independently plan their activities within the network. These units exchange and collaborate to realize their plan. The study aims at adding value to the strategic, tactical and operational decisions made in the Canadian forestry supply chain being characterized by a long cycle time – from harvesting to delivery to customer – and with little value creation activity. The team is developing an experimental platform allowing testing of different supply chain configurations for the forest products industry and different planning approaches for all the business units of which it is comprised. Different intelligent agents are in charge of sending requests and receiving commitments for new or modified requirements (product or processor), generating a plan to respect commitments or updating the commitment status. Details of software architecture and software components (supply chain modeller, planning unit, operational coordinator, tactical and organizational coordinator) were given.

The Human Factor

Eric Childress, Consulting Product Support Specialist, OCLC Online Computer Library Center, Inc. Dublin, Ohio, USA, titled his presentation, "Humans, Interoperability and Libraries". Mr. Childress focused on the human aspect of information, the history and role of libraries in the information process, and new trends and projects in the library world.

Mr. Childress considers librarians as the 'wetware' of the information process. Good systems design requires excellence in defining and anticipating user needs. Information professionals have learned a lot about user needs and, as humans, are good at fuzzy logic so they can help in the development of systems and help translate them to other humans. Information professionals (i.e. librarians) speak both human and machine.

In reviewing the three levels of development of interoperable systems, strategic (developing agreements and partnerships), tactical/operational (determining who does what), and technological (developing systems and standards), Mr. Childress warned that while humans are involved at each level, they can be different personnel at each level. Weak commitment to the project at any of the three levels can ultimately result in underperformance or failure of the system. Making changes in the system once it is developed can result in heavy human costs for rethinking, retraining, rewriting or replacement of personnel.

Mr. Childress then turned to a history of libraries and their involvement with information management. Libraries have 2000 plus years of experience in the selecting, organizing, providing access to and preserving of information materials. In addition, librarians have become experts at copyright and privacy issues and the economics of information as well as at establishing standards, networks and cooperative agreements. The over one million libraries in the world hold billions of information objects, 80% of which are out of print and most of which are not on the Web.

Information management progressed as the medium of expression developed from clay tablets to vellum to papyrus to paper. An early form of metadata was used to indicate what was contained in these information objects as the collections became institutionalized in temples, schools and scriptoriums, and later in libraries, archives, museums and records centers. Standardization developed through script normalization, vocabulary control, metadata and records management systems. Most libraries were private at first, and development was slow until the 19th Century when revolutions in paper and printing caused a significant increase in the amount of materials published and consequently, in the rapid growth of libraries. The development of the Dewey Decimal Classification, shelving systems, book catalogs and national biographies helped bring order to this new material.

In the 20th Century, other time and labor saving practices were developed which culminated in the first standards for machine readable cataloging which was developed by the Library of Congress, ushering in the computer age in libraries. These MARC records allowed for the development of bibliographic networks such as OCLC, Online Public Catalogs (OPACs) and other cooperative ventures such as large union catalogs and interlibrary loan systems. The development of the Z39.50 protocol allowed federated searching of multiple catalogs.

The global network took off at this point with the development of internet and web-based systems. Use of metadata standards and better cross system protocols enabled more access but also increased the expectations of users. Now users expect more and more materials to be available at the desktop and require 24/7 reference services. Digital resources are expanding which is making previously hidden resources more accessible. In the meantime software and data files are multiplying which makes the information world even more complex.

Eric then gave a brief history of OCLC. This non-profit company in Dublin, Ohio started as a local network provider and developed to become the world's largest library cooperative working with 45,000 libraries in 85 countries including major national libraries. They are a significant player in the library domain through development and publication of the Dewey Decimal Classification, MARC formats, and Z 39.50 protocols, as well as interlibrary loan and preservation standards and systems. They are the hosts of the Dublin Core Metadata Initiative. World Cat, a union catalog of library records representing the holdings of their client libraries, helps establish the interoperability of records by requiring strict standards of entry and form.

A number of new issues and ventures are of interest to libraries. The semantic web, which offers advancements in the search and retrieval of information and the mapping of concepts; data mining and harvesting; digital preservation strategies; knowledge rights management, and collection management and optimization are all areas of new research by libraries. Eric mentioned several efforts in which OCLC participates: SRU/SRW, search and retrieval on the web using XML encoded Z39.50; FRBR, Functional Requirements of Bibliographic Records, being developed by the International Federation of Library Associations and Institutions (IFLA) and providing a hierarchical model for presentation of information; OAI, the Open Archives Initiative, a light weight protocol for publishing documents and metadata; OAIS, the Open Archival Information system, developed by the Consultative Committee for Space Data Systems, a conceptual framework for an archival system dedicated to preserving and maintaining access to digital information over the long term.

Eric Landis, a Forest Information Management Consultant, specializes in organizational aspects of information management and has worked with numerous government agencies on data and metadata management planning, user needs assessments and documentation. He is a member of the IUFRO Global Forest Information System Task Force. From his experience with the GFIS project as well as other projects such as the NSF-funded Adaptive Management Area's Portal Project, Eric stressed the need for a full user assessment before beginning a major project. Assessment never ends for a project but is a cycle progressing from user needs to potential features of the system, to assessment of costs and subsequent setting of priorities and making changes, and back to user evaluations of the system and further changes. Initial user assessment is necessary to meet the needs of the ultimate users, to justify the project to funding agencies, to promote the developed system, and to reduce overall costs. The farther one gets into a project the greater the costs of change, both in money and time. There are a number of ways to conduct user assessments--focus groups, interviews, workshops, questionnaires, observations, internal and external studies, but the important point is to do something, however restricted or incomplete it may seem. Eric suggested asking users to develop scenarios, stories, as to what they would like the system to enable them to do. Documenting these stories will allow systems designers to translate these needs into system components.

When queried, most users indicate that they want standard features such as ease of use, available whenever wanted, containing the right information (i.e. what they need at a given time), and other similar characteristics. However, each project may have individual and specific user needs. Some things can go wrong when conducting an assessment, including: selecting and sticking with the appropriate user community; interviewer's desires overriding user needs, and difficulties in communicating user needs to system developers.

"Needs Assessments and Partnerships: The Evolution of a Natural Resources Digital Library at Oregon State University", by Bonnie Avery, Janine Salwasser, and Catherine Murray-Rust, was an example of the human dimension of interoperability with the authors representing the partnership of a librarian, a geographer and an administrator. As a means of expanding the traditional library role of providing access to natural resources information, in 2001 the OSU Libraries decided to create a digital library based on user needs in relation to content, access, geographic scope, uses and usability and services. They planned and conducted a user needs assessment using face-to-face interviews and a workshop with a variety of potential user groups. The results of this study indicated that users were able to articulate that they needed a wide variety of natural resource information in a variety of formats with a great interest in forestry, watersheds and land and water use. The system needed to include both spatial and non-spatial information, provide information integration and synthesis as well as evaluation of information quality and facilitate networking among users.

With this information, the planners realized that a variety of partners with different expertise would be necessary for full development of the portal. Partners for the project would require participants from the library, computer science, natural resources and social sciences communities joining with public agencies, planners, educators, conservation/restoration groups, decision makers and researcher to complete the project. Several case studies of natural resource digital portals completed the presentation. While partnership motivations varied from project to project, several factors contributing to partnership success were revealed. Partners must have a shared community of interest, realize mutual benefits from the project, must each have an executive champion, be able to provide a needed expertise, and be able to provide money and in-kind contributions to the project. In addition, each participant must have a good track record in collaboration, communication and outcomes.

Debra Dietzman and Thomas Schmidt, in “Finding Common Ground: A Conceptual Approach for Selecting Web Site Content”, described a project within the US Forest Service to provide access to information and data generated by the agency research community. Delivering this information so that it can be put to use in society has been problematic. This presentation focused on a conceptual method to determine what information should be included on a web site and how to choose and organize it. The developers wanted to develop web pages that would deliver the relevant science in a sustainable stream of web content and would anticipate future needs. The system required systematic capture of the information, a common information structure and an organizational commitment to gather the research information.

The project utilized a database of required study plans to be completed by researchers before funding for the studies would be granted. Using web-based input forms the researchers provide structured descriptions of research projects. The researchers also contribute summaries of the research once the projects are completed. This database helps to institutionalize the information, creates a warehouse of completed studies, and helps manage the investment in web resources. Several products have benefited from this storehouse of research information including TreeSearch, a searchable database of Forest Service publications, customized CD-ROMs containing user selected publications, and the Forest Inventory Assessment (FIA) Mapmaker. As a whole, the project resulted in a system that creates demand for the information, simplified design of products, and kept the content focused. It is responsive to changing conditions, adaptable to future technologies, and sustainable.

Alois Kempf, of the Swiss Federal Research Institute (WSL) has long been interested in the progression of knowledge made possible through information linkages. In “From References to Knowledge Links and Full-Text Documents” he describes both the opportunities and barriers present in accessing information. Recent developments in information technology and the dissemination of scientific knowledge have changed the ways researchers are accessing scholarly documents. Enhanced reference information such as cited reference databases, and open URLs and metadata links in web-based publications have built upon the traditional bibliographic citation. Full-text access has been made possible through online publication such as html and pdf formats, interlibrary loan systems, and pay-per-view systems among others.

But access has some significant barriers. Web search engines are limited by coverage, ownership, ranking of sites and localization. Access to information is also limited by ownership rights and subscription costs, limited to those who can pay or with affiliation to a particular institution or group. Other barriers to access include the lack of interoperability in databases and systems, requiring special training or knowledge to master the navigation within and between databases and full-text publications. Some developments such as digital object identifiers (DOI) and open URLs are helping overcome that barrier. One promising method for finding relevant information on a topic is by using a thematic portal, using an institution and its authors and documents as a way to expand on a topic following the trail of hyperlinks and semantic relationships to find new information.

Jennifer Gaines of the USGS/NBII Program integrated her own presentation, "Developing a National Biological Information Infrastructure and Sharing Forestry Information", with that of Ella Ellman, "Pacific Northwest Information Node: Sharing Forestry Information with the Public". Jennifer coordinates several projects relating to NBII, including the development of a metadata standard. Her presentation described the origins and objectives of NBII, the partnerships and international connections of the service, and its structure and activities especially those related to forest information. The NBII provides a mechanism for accessing existing natural resource data, information products, and analytical tools that support and enhance science-based decision-making. The project has a number of goals including promoting interoperability of systems and supporting knowledge discovery for biological and ecological resources. Many partners have contributed to the project including universities, government agencies, conservation groups and business. It serves as a national link between local and global information systems including the Global Forest Information Service (GFIS) and the Global Biodiversity Information Facility (GBIF).

NBII structure includes three kinds of nodes: regional, thematic, and infrastructural. The nodes provide content delivery, data warehousing, data mining, analysis and synthesis, technical support and interoperability, and collaboration. NBII activities include helping to develop standards for web content, metadata, and geospatial data, and developing thematic web sites and databases among other projects. Forest related projects are primarily located at the Pacific Northwest node and include projects in partnership with the US Forest Service, the University of Washington, Oregon State University, Northwest Habitat Institute and others.

The conference concluded with "Knowledge management in the forest products industry: the role of centres of expertise" by Constance Van Horne, Jean Marc Frayret and Diane Poulin of the FOR@C Research Consortium at the Université Laval. The full paper is available elsewhere in these proceedings.   Constance described four trends currently affecting the industry: consolidation, optimization and innovation, customer oriented value added products, and environmental issues. The researchers from FOR@C believe that knowledge management will help the industry cope with these issues. The knowledge value chain (innovation-data-information-knowledge-dissemination-application-innovation cycle) and the knowledge value network, which captures and increases company competencies, are both important in this process. Industry centres of excellence contribute to industry knowledge management by partnering with companies and disseminating research and publications about the process. They can develop tools to help turn research into innovation, which will assist in turning industry challenges into opportunities.