Plan to Develop a Digital Information Infrastructure to Manage Land Grant Information

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This paper is a compilation and update of four other papers that were written within the last two years.

> *Plan for Agricultural Information Management and Outreach*. Randall Heatley, Janet Poley and Peter Young.
>
> *National Digital Library of Agriculture*. Randall Heatley and Janet Poley.
>
> *Proposal to Create a Digital Information Infrastructure*. Randall Heatley
>
> *A Possible Knowledge Sharing Model*. Randall Heatley.

I have attempted to consolidate the ideas contained in those papers and provide additional ideas.

Table of Contents

Plan to Develop a Digital Information Infrastructure to Manage Land Grant Information

Historical Perspective and Introduction

Developing a National Plan for Information Management is a complex task involving a broad set of actors involved in the system. The plan must be "living", global in scope, strategic, affordable, amendable, open to continuous improvement, based on best possible knowledge and capable of transitioning with future times. The information planning environment today is quite different from that of yesterday. Customers want what they want when they want it, they want top quality information, they don't care where it comes from as long as it is reliable and relevant to their needs and interests. Everything is becoming digital in a wireless world where eventually everyone can be connected anywhere, anytime.

The Land Grant university (LGU) system was established by the Morrill Act (12 US Statutes 503) in 1862 to respond to the educational and information needs of US communities. For more than 140 years, these LGU institutions of public higher education have grown to become the largest adult and youth educational organization in the nation, providing publication, outreach, and distribution services for practical knowledge on an astonishingly wide range of subjects related to agriculture, use of solar energy for agriculture, home economics and rural energy. Enactment of the Smith-Lever Act in 1914 (amended in 2002) created the Cooperative Extension Service by which Land Grant institutions provide citizens with agricultural information through demonstrations and publications.

This Federal State partnership has produced publications deposited in library collections and institutional archives throughout the nation and around the world. However, no comprehensive plan exists to assure that this important and valuable legacy national collection of agricultural information is properly identified, described, managed, and preserved There is an urgent need for such an overarching plan to coordinate and manage so as to preserve and assure future access to and preservation of the universe of this rich information resource for the nation. A national plan for Land Grant information management will provide standardized procedures for management and preservation, so that comprehensive and relevant agricultural information is immediately available to future generations through extension and outreach services. This document describes such a national plan for information management assuring that this legacy information will be available through inreach and outreach mechanisms for future generations.

Today Land Grant universities focus on the management of people, facilities and funding. Alternatively this system might better be seen as a unique vehicle for generating knowledge and information as its primary output. From this perspective, resources (people, facilities and funding) are intended to be used to create knowledge and

information production which may be used to educate the public and yield solutions to practical problems.

The organizational structure of the U.S. LGU/Cooperative system is more than a century old and still determines and proscribes to a great extent, how information should be managed and delivered. New technologies are making it possible, however, to create and manage information and knowledge independent from organizational structures appropriate to earlier times. These new technological possibilities allow management of information as a primary resource in a manner that maximizes its usefulness to the customer. Now is the time to consider blending organizational and informational concerns through increased networking and greater use of digital technologies.

This is a multi-dimensional national plan incorporating the unique aspects related to the management, dissemination, and preservation of information. This information was generated primarily to help citizens improve their lives and communities. Inreach is increasingly possible as citizens look anywhere and everywhere to find appropriate and relevant information to address needs and problems. Outreach, primarily through Land Grant University Extension and Engagement programs, makes the information useful to citizens by providing context and shaping information resources to solve problems and to improve lives. A comprehensive management system will increase the resources available for educational programs conducted by county Extension Educators and university specialists and faculty.

This national management plan addresses issues related to both library/information services as well as outreach and engagement activities of the Extension system and the foundational digital infrastructure. The plan attempts to achieve synergistic value from a blend of human capital expertise, information content resources, and digital networking technologies. It attempts to leverage current resource investments in a decentralized cooperative structure that emphasizes the importance of putting information and answers into the hands of the customer rather than in an underused library or archival collection.

A comprehensive management plan will provide an information inventory and allow the agricultural information management system to be queried to better determine the resources available from all sources for a particular subject. Knowing which information is available helps determine the gaps in the knowledge base. If the gaps are known it will be possible to inform the research component of the Land Grant system as to which areas of research might fill the gaps.

The plan assumes, indeed requires, that information users (customers),libraries, outreach and engagement programs and Land Grant University research collaborate to develop and expand the agricultural information management system. Much of what is described in the plan falls within the purview of libraries and describes functions they have performed for many years. Consequently, later sections will relate how the outreach and research components are essential to the success of any system that purports to

manage agricultural information. The final sections of the paper describe proposed actions that may address the information management needs of the Land Grant system.

The Characteristics of Agricultural Information

Agricultural information can take many forms and be either old or new. Old or legacy information still has a good deal of utility. Old Extension publications are used by researchers in a variety of disciplines. These old publications may also be useful to practioners and countries where the information is appropriate to the agriculture being practiced. (New does not always equate with "best" information for the situation.) Old research reports can often provide a starting point for new research efforts. The identification of legacy information to include in the management system will be a component of the plan. Much of the current and past information is in print. The plan must take into consideration how printed materials will be converted to digital format, if desired, and what will be done with the actual paper copies.

More recently created information will be in digital format. This can be an advantage because the information can be readily distributed and lends itself to electronic management systems. However, electronic information may also be difficult to archive and manage. Information which exists only in digital format may be ephemeral and so the plan must consider how or whether such information will be captured and managed. An additional complication with digital information is the material and format in which the digital information is available i.e. magnetic and optical storage formats can complicate the management of this information requiring explicit concern for translation from one format to another.

Agricultural information may also be visual material. Older materials may 35mm slides, kinescopes, 12-inch videodiscs, videotapes of various sizes and videocassettes in various formats. Some of the visual storage media have a fixed useful life and many original materials deteriorate through improper storage or age.

Curriculum and educational aids also contain considerable valuable information. Again, these materials can be in various formats from print to the educational aids provided by presentation software.

Considerable bodies of information walk away from the LGU community each year as our most experienced employees retire. At present no one has gauged the amount of material lost, amount of material about to be lost, nor the potential damage to be inflicted from such loss. Certainly some of these people have left a body of published information, images, course syllabi and other materials. It is certain that a considerable amount of information that did not get published is lost. This could simply be the accumulated wisdom of conducting research or outreach programs. It could be the lessons learned from research that didn't go exactly as planned and so was not published yet may be a starting point for another research project. At the very least, some

measurement of this loss would be advisable and if considerable, a remedy should be found.

Goals for the Management Plan: Standards Critical

The goals of this plan can only be achieved by the identification and adoption of standard procedures and techniques throughout the system. The premise of the plan is that information management of individual resources is best accomplished close to the source of that resource. The "electronic library" will be composed of a large number of smaller, independent but highly interoperable repositories. These are most likely to be libraries but, depending on function, may also be information and technology units closely associated with LGU, Extension Services and Agricultural Experiment Stations. Interoperability among these localized units is critical and will be greatly dependent on the adoption of shared standards.

Standards to Describe the Resources

Standards for describing the resources are a fundamental requirement. The metadata set should be sufficiently robust to account for future needs. The desire to have many data elements must be balanced with what number is practical. In addition, many sites already have metadata records for resources that would likely be included into the national system.

Standards to Share the Metadata: Collaborate, Search and Harvest

Standards for sharing the metadata will be another significant goal. It is no longer necessary to have large, central repositories of metadata. Technologies exist that allow the metadata to be maintained in situ and either collaboratively searched or harvested. Shared metadata could be placed in centralized repositories that specialize in a particular subject. These could form the nucleus of particular communities of interest and the resources could be combined with outreach and research assets. In essence, the standardized metadata can be maintained in many places, it just needs to be exposed to the system.

Standards for Searching

Given the development of standard metadata fields and the sharing of those fields, standards for searching can be developed. Search technologies will be described in later sections. Search tool options could be centralized tools that search across the entire system or subsection of the system. A system could be designed to allow users to add specific search tools to their desktop. Again, search tools can be generic or developed specifically to find resources related to a particular subject or to find a particular resource type.

Syndicated Resources: Cost -Benefits

Syndication of the metadata will allow resources to be shared seamlessly but has both positive and negative dimensions. Syndicated resources can be transferred seamlessly from one repository to another, thus the same resource is stored in multiple places. A moderate amount of redundancy is an advantage to preserve backup copies and to spread the load for public access. If done to excess, the same resource takes up valuable storage space and concerns develop as to whether the duplicate copies are the most current. The ease with which syndicated resources can be obtained can make it easier to assure that the most current copy is disseminated.

Identifying duplication will be possible as the national system becomes connected and an information inventory is conducted. The level of redundancy and duplication of resource content can be more properly assessed and identified rather than being assumed to be undesirable. Duplicate titles may indicate that a subject is of interest over a broad area. However, the actual content of these presumably redundant resources may have significant, large or small differences. By looking at sources of truly identical resources it may be possible to determine which areas – geographic and subject – are duplicated in the system. Analysis of such duplication also provides a measure of specific context unique to states and counties as they provide information to their audiences. Subjects that are truly duplicated and for which there is a large consuming and provider community could be provided with alternative information management and creation options.

Procedures for Implementing Standards

Selecting Dublin Core as a metadata standard or NALT as the thesaurus is a good starting point. However, much is still left to the discretion of the institution as to how the standards are used and what is actually in the metadata record. Some consistency across institutions is necessary if multi-institutional search tools will retrieve similar records on standard search terms.

Identifying the Gaps in the Agricultural Knowledge Base

The comprehensive management of agricultural information will make it possible to identify gaps in the agricultural knowledge base. Knowing where gaps exist can help inform the Experiment Stations or other research oriented entities as to which areas of research are needed. Because the information management system is national in scope, the approach to filling the gaps could also have its own national strategic plan. The federal partner may be able to use such information to provide grants in areas where research is limited but needed.

Preserving Agricultural Information

Preservation is another goal of the national plan. The need for preservation of agricultural information has several dimensions. Some of the most common are listed below.

- Old information resources are often the starting point for new research efforts. It is often surprising to find out how much work was done in past years but the present research community is unaware of its existence.
- Older information may be in obsolete formats or formats that are in danger of deteriorating past the recovery point. This is not just an issue with printed materials but also with videotapes and various digital media.
- The Land Grant community may now be posting information that has value but exists only in digital format. Such files may be updated and overwritten thus extinguishing any possibility of capturing the resource for an archive. The ephemeral nature of information in the age of the Internet may actually make it more unmanageable than older paper archives. (We used to discuss inability to access gray literature. Today many are deeply concerned about many of the Internet resources being more fleeting and less accessible long term than anything predating this form of publication)
- Assuring the existence of older resources does not assure they will be available for use. The preservation effort should also make sure that the resources are hosted so they can be used by the public, outreach and research communities. The plan will need to compartmentalize the preservation effort so that preservation efforts are not duplicated on the same set of resources.

Outreach and Engagement – Making the Information Useful

One of the strengths of the Land Grant University has been the presence of Extension Educators in counties. The community-based staff provides a local front door for the university to understand the conditions that individuals, families and communities are facing. Information is made useful by providing a context for its application in solving local problems or conducting educational programs that increase human capacity. This strategic plan must move beyond describing a means for providing well-managed archives; the strategy must assure that communities and individuals have access to and are "engaged" with information relevant to their lives. After all, these local citizens through their tax dollars have paid for the creation of this information.

Extension is also one of the main sources of agricultural information. Extension bulletins are an obvious example. However, Extension bulletins do not represent a majority of the agricultural information products produced by Extension. Extension Specialists and Educators produce quantities of information. These may be handouts in offices or programs, educational program outlines or curriculum, image collections, radio programs, audio cassettes, video programs and a vast array of other information. Much of this information will be rich with local context and presents a valuable but largely unknown information resource.

Extension is also one user interface to LGU information. Interaction with the customer suggests that those engaged in outreach (includes both extension and research staff) will have information resources that reflect ground truth. It's one thing to record research results and write it up in a paper. It's an entirely different thing to see how that

same research was actually applied by customers. Local information of all types is very valuable and the communities at the edges of the network should be considered to be in the center of the agricultural information system not as passive, peripheral recipients of information. In addition, county educators, producers and other local leaders will be able to provide insights into useful practices developed in the field. County offices may be the first place that new and emerging issues become known to the system.

Citizens will participate in this system in many ways, including through local Extension. As consumers of information, they can help the system identify information gaps. The site specific local horticulture programs are probably the best and most effective examples of interaction effects among consumers, extension educators, master gardeners, university researchers, nurseries, gardening retailers, local media, regional repositories and national systems. Citizens may also be sources of useful knowledge. Just as libraries deal with gray literature, citizens may be a vast resource of "gray knowledge" or ground truth. This information can be context rich and provide valuable, site specific information. Through interaction with Extension, such knowledge may be captured and shared with others.

Feedback from the Outreach/Engagement Programs to the Information System

Outreach can provide feedback needed to assist the information system in a number of ways.

- Does the array of information provided meet the needs of the customer?
- Is the type of information available suitable for their needs?
- Are the information search tools and delivery methods usable?
- Do customers need information from sources not included in the information system?
- Does the system provide information in a timely manner through useful delivery methods?

Outreach professionals have a key, multi-part role in the agricultural information system. In the course of performing their mission, they will generate information that is captured by the information system. They will also use the information in the system to complete their professional duties. Local staff will also be an essential source of feedback regarding a number of parameters associated with the agricultural information system.

Research – Adding to the Knowledge Base

A primary source of agricultural information is the research community which includes the state Experiment Stations but the strategy casts a wider net and includes agricultural research from any reliable, authentic and creditable source.

If information is to be a managed resource then there must be some mechanism to fill gaps in the knowledge base. This is not to imply that research "assignments" will be

made to the research community. However, it should be possible to suggest or create an agenda of needed information or problems that require a solution.

Research is more than just published articles or research reports. Considerable amounts of valuable materials are produced in the course of conducting research. Field notes, images, notes from failed experiments and other resources have value but may get discarded, lost or deteriorate with time after a researcher leaves. Capturing these materials would allow future researchers to avoid problems or at least begin in a more advanced state of knowledge regarding the problem.

Increasingly the lines are blurring between Outreach and Research. Many LGU faculty have split appointments, field staff may have research expectations and members of the public go directly to whatever source irrespective of location or title if they think that person has the "best" information or possible solution to their problem.

Techniques and Technologies to Achieve the Goals

The array of technology available for managing information enables the creation of an extensive collection of information and knowledge without the creation of large, centralized repositories. The plan suggests that the large gains in information management capability can be realized by the adoption of standards and some level of interoperability. Each entity in the agricultural information system can manage their information resources in the manner that best suits them BUT all entities must adopt a minimal set of standards to share the metadata and assure that the metadata records are comparable across entities.

What?

Standards development must focus on three primary areas:

- thesaurus,
- metadata elements,
- and methods of operation.

Who?

The development process will require the identification of a group of experts to formulate the professionally agreed upon standards. However, the standards should be modest with respect to the resources that participating institutions will need to provide. The information systems at participating institutions are the bricks in the information structure; the standards provide the mortar needed to hold them all together.

Thesaurus (NALT)

The National Agricultural Library Thesaurus (NALT) has already been designated as the official thesaurus of USDA. If NALT is not adopted it should certainly

be the staring point from which the thesaurus deliberations begin. NALT already has in place a mechanism by which it can be updated and expanded. In addition, Web services will likely be heavily used in the agricultural information system. Web services are already in place to enhance the functionality of NALT. The NALT has also been adopted by several LGUs including Louisiana State University and Michigan State University as well as eXtension.

NALT as Knowledge Domain Schema

The agricultural information management system may want to create repositories that are structured as knowledge domains. Knowledge domains use an internal schema by which the information resources are organized. To enable sharing of metadata through syndication, the schemas of the knowledge repositories should be the same. NALT has already been successfully used as a knowledge domain schema.

Metadata Structure: Start from AgNIC

Like the thesaurus, there are suitable existing options for the metadata structure. Rather than specify an entirely new metadata standard, the standards development group should identify the set of essential fields necessary to share the information. A minimal set of data elements is probably present in most existing management systems. A suitable starting point may be the minimum required fields used by the Agriculture Network Information Center (AgNIC) alliance. Individual institutions are free to use a system with a highly complex metadata structure. The metadata structure envisioned by the plan is simply the sharing of a small number of fields so as to enable interoperable information searching and sharing.

Web Services Can Enable: XML Data Definitions

Web services seem to provide the most promise as an enabling technology for the agricultural information management system. The use of standard information management techniques enables the development of a standard, shared library of Web services. Shared Web services create the necessary interoperability among institutions that will enable the development of the agricultural information management system. The use of Web services will require the development of a set of XML data definitions for use across the system. Web services will need to be developed for the following functions.

- Metadata syndication will enable one information provider to share with any other provider assuming they have adopted the same standards. This should not be construed to mean that all repositories should contain the same information as all other repositories. Some redundancy will be necessary to spread loads on servers and to provide backups.
- Search Web services must be developed. Institutions that adopt the standards can be searched, in theory, by a single web service. However the standards development groups will need to give this some thought. Search services that allow the user to select the institutions or repositories to be searched will probably

be required. It should also be possible to create Web services that search for resources pertaining to a particular subject or resource type.

- Web services can be used to bring search tools to the desktops of users. One example is the use of Web services to provide a search tool through the Microsoft Office Research Task Pane. Users or university employees will not need to actually go to the repository Web site.
- A group of utilities that harvest metadata records, provide input capability or other functions may also be required.

Plan for Central Support System

A central support system provided by a single university for institutional memory purposes will be required for the information system to:

- develop and update the standards adopted by the system.
- provide technical support to institutions that may not have the technology expertise required to make the Web services or other standards work.
- arrange for periodic meetings to provide updates or review standards will be needed.

Some institutions may develop specializations within the information system. These could be backup functions to those performed by the central support entity. However, some institutions may have specialized knowledge on the development of Web services and could provide technical support to the system. In some cases, specialized knowledge may relate to a particular customer community such as international consumers. It is highly likely that some institutions will have specialized knowledge about the resources available in a particular subject area.

Expanding the Agricultural Information Community

Critical Partners

In order to simplify the description and development of the strategic plan, only a few of the entities that must be involved were named i.e.libraries, Extension and Experiment Stations. However, this Agricultural Information Network must engage a great number of other entities. Many institutions will create various types of agricultural information. Some of them are listed below.

- Universities that are not part of the Land Grant system
- International educational institutions
- U.S. and international governmental agencies
- Commercial agricultural entities
- Professional societies
- Commodity groups

ADEC: American Distance Education Consortium

Another type of institution that will surely be involved will be those who are involved in distance education or use the system as a resource in teaching. An example is the American Distance Education Consortium (ADEC). The agricultural information management system will consist of widely dispersed institutions. The use of distance education to update the system and educate users will be a necessity. However, distance education expertise and capability are not the only contributions to be made by Land Grant consortia such as ADEC. Additional examples are listed below.

- The ADEC IDEAL project identifies high quality educational programs that may be of value to educators in and out of the Land Grant system.
- ADEC is currently developing a digital libraries educational distance education program. This effort provides a forum to identify issues and foster discussion within the library community. In addition, non-librarians can identify areas in which they can collaborate with libraries.

International Aspects of Knowledge Management

In a global economy, the agricultural information system must consider the international aspects of knowledge management. The agricultural information systems of other counties will also produce resources that will be useful to the U.S. system. Some agencies have long standing relationships with international consortia or non-governmental organizations. Examples are listed below.

- The National Agricultural Library (NAL) has had a long term, collaborative relationship with the Inter-American Institute for Cooperation on Agriculture.
- ADEC, The Agricultural Network Information Center (AgNIC), and Michigan State University are working on a project to create a Western Hemisphere Information Network.
- Organizations such as the United Nations also have information and knowledge management efforts that could be partners or resource providers.

Critical Success Factors and Continuous Improvement

Critical success factors are listed below.

- Ability for all LGU to participate equally in the system, regardless of size.
- Increased access to Land Grant knowledge products across the entire system as facilitated by fully interoperable knowledge repositories.
- Greater array of knowledge products available to Extension and research components.

- Increased capacity to respond, as a system, to disasters via technology assistance and mobilization of information resource pertinent to the type of disaster and region where the disaster occurred.
- Inclusion of non-Land Grant institutions in the system.

Continuous improvement will be accomplished by the following actions.

- Review and upgrade standards used to create and facilitate institutional interoperability.
- Land Grant employees will be asked to rate the system to measure the quality of information resources and usability of the system.
- Collection development teams will review the collection development plan to assure that emerging issues or information needs are represented in the collective repository.
- Feedback, obtained as described above by the infrastructure component, will be used to add, modify or eliminate features.

Funding Partners

Land Grant institutions will constitute a major source of recurring funding or resources. The bulk of the necessary resources may be simply a redirection of current functions into digital Land Grant priorities. Examples of resources that could be provided by institutions are listed below.

- Information technology expertise and equipment to support institutional knowledge repositories.
- Providing, perhaps with some funding, expertise and systems to perform core digital Land Grant functions as coordinated by the infrastructure group.
- Addition of metadata to institutional knowledge repositories.
- Coordination with other institutions to scan and preserve resources that are not now available to the system.
- Possible recurring funding to the infrastructure functions along the model of ADEC or eXtension.
- Participation in the management and development of the digital Land Grant system.

The next section of the paper proposes the development a digital information infrastructure. The proposal takes into account the mission of the Land Grant system and addresses the need to have a more flexible and modern system. In addition, the proposal attempts to save those characteristics and functions that have been the hallmarks of Land Grant programs. The proposal does not try to remake the Land Grant system but rather suggests and proposes changes in knowledge management methodology.

Components of the Digital Information Infrastructure

Digital Information Infrastructure Consortium

Situation

One assumption throughout this paper, and in discussions at various venues, has been that of interoperable knowledge repositories to create a potential national digital information system. Yet, there is no overriding agency, group or institution that appears to be facilitating such a process or is recognized as having the lead. If a national digital information infrastructure is a desired outcome, it must shortly find a home. A significant amount of planning and coordination must be done before many of the following steps can be taken. At some point, a governance function must be identified and implemented. There is an urgent need for the creation of a group or institution that can serve as the condensation nucleus for this effort. The proposed digital information infrastructure consortium can meet this need.

A consortium of institutions could agree to develop an infrastructure standard. To begin, this could be a combination of American Distance Education Consortium (ADEC) and Agricultural Network Information Center (AgNIC) partners. Both organizations are already successful collaborations so would have considerable experience in the mechanics of consortium and consensus building. The consortium would agree to develop and implement the Digital Information Infrastructure Standard (DIIS). The items listed below would be steps in such development and the umbrella group would be the DIIS institutions. Perhaps DIIS participant institutions would display an icon or logo on their sites as do AgNIC partner.

The intent of the DIIS is to provide the foundational standards necessary to provide consistent knowledge repository functions across multiple institutions and agencies. The basic assumption is that digital infrastructure begins with institutions gaining control over their internal information environments and then working together to create a more robust external information environment. The DIIS will need to be sufficiently flexible so as to provide connect points for those who want to expand the basic standards to create additional functionality. A number of new possibilities are enabled by creating the foundational infrastructure.

- The DIIS could be used as a stepping stone for Land Grant Universities to create digital libraries based not on institution but rather subject matter or issues of national importance. Digital libraries could enhance the metadata standard for particular subject resources and provide guidance in use and development of various thesauri. However, the foundational standards would be those defined as DIIS. Digital libraries are discussed in a later section of the paper.
- ADEC may build on the DIIS to create an educational resource repository and adopt a different thesaurus and additional metadata standards. Such efforts would assist the distance education community but again would be based on DIIS.

- Additional specialized information or expertise centers could be developed. Because institutional resources are shared in a consistent manner, they can be mined to create specialty collections. More discussion about information centers is presented in a later section of the paper.

In all cases, the beginning point for funding and implementation is the DIIS. Some sort of DIIS governing board or entity will be required. However, it should be able to be started with representatives from existing partners.

All of the other components of the digital information infrastructure will rely on the development of the consortium. The consortium must provide a home to various functions. Some suggested functions are listed below.

- Assist in developing specifications for a knowledge repository application that can be sustained and deployed at institutions with varying technology capacity. Assist in running trials of existing applications.
- Develop organizational structure for central support that has the following characteristics.
    - Information technology redundancy across institutions sufficient to assure adequate hosting, searching and backup capacity with server loads distributed more or less equally.
    - A system of shared institutional memory so that standards are not only maintained but their development and rationale for adoption can be explained.
    - A technology support capacity for institutions that have insufficient resources or talent to use digital Land Grant applications and standards.
    - Training capacity to provide internal support to digital Land Grant participants in the deployment, problem-solving and maintenance of the system.
    - An educational component that will eventually teach users how to access the system and to provide information about the resources within the component repositories.
    - Regular communications to inform LGU participants as to progress, new technology, new resources, suggested changes and to obtain feedback.
    - A strategy to include institutions and entities that are not Land Grant but wish to participate in digital Land Grant. Perhaps one of the "official" LGUs could take the lead in each state to coordinate efforts with other state universities.
    - Create an emergency or disaster response capacity that provides technology and information resources appropriate for the situation. Such capacity may include not only communications assistance but also virtual reference desk assistance around things such as food safety, housing, and other topics of concern to victims.
- Create a strategy to obtain a combination of recurring and grant funding.
- Review system-wide standards and offer suggestions for improvements.

The over-riding assumption for all of the following steps is that there will be a consortium or other entity that will provide leadership for the digital information infrastructure.

Suggested Action Steps

It should not be necessary to create an entirely new entity to assume the responsibilities of the digital information infrastructure consortium. Existing entities, such as ADEC, already exist and could, with augmented resources and in consultation with other entities, assume the responsibilities outlined here. Incorporating other groups such as AgNIC will provide a broader information management knowledge base. Consequently, the only suggested action step is that an existing entity or entities agree to assume responsibility for consortium development once funding is secured.

Assess the Information Environment

Each institution exists within an external information environment and creates an internal information environment. Determining the existing state of the information environment is a necessary first step to creating a digital information infrastructure.

Situation

Universities are rich sources of information in an era that features an information economy. For purposes of this paper, the working assumption is that most institutions are trying to support digital information delivery systems with infrastructure and procedures that are geared toward print media. In addition, information management techniques tend to view electronic systems as though they produce printed output. Much of this assumption is based on the author's observations and not any sort of research. Specific assumptions are listed below. These may be the case to some degree at most institutions but there is no suggestion that they are universal truths.

Environmental Assumptions

Knowledge institutions still exist as silos of information. Indeed, the only systemic way to search for information resources is to use commercial Internet search tools. Such searches inevitably provide searchers with large numbers of extraneous hits, some of which are not appropriate for the searcher's needs. Institutions need to develop the capacity to share information so that a single information system is created.

A single system also provides information management and delivery on a scale that will allow the system to compete successfully in an information economy. While it will be true that individual institutions will generate and manage information for local needs, no institution will be able to generate all the information it needs. Consequently, a holistic approach must be created to information management. Access to information

across the system plus the ability to access information from outside the system are minimal requirements for success.

In an information economy, the successful institutions will be those that can access most of the information available to them. Most institutions, or consumers of an institution's information, are unable to find the information directly. Searchers must first find the department which may possess the information and then the person within the department who knows the information.

Informing people is not the same as solving their problems. Providing solutions to problems means having the information that is applicable to the problem and being able to provide it within a context that makes it useful to the consumer. Joseph Nye, in *The Paradox of American Power*, points out that when information is available in abundance such abundance dilutes attention to the appropriate information. Nye also points out that credibility of the information source becomes more important.

The WWW has disintermediated knowledge organizations and governments(Nye). Information seekers go directly to Internet search tools rather than seek information at universities. Inevitably, they will find information but it may be inappropriate for their situation. By going to the Internet, they bypass the information professionals who would have assured that they get the correct information plus the interpretation that would make it useful.

Institutional Assumptions

Information and knowledge are perhaps the primary resource available to universities. However, most universities have not developed information infrastructures that manage this resource in its totality. Institutions will need to develop information management strategies that allow them to find and access all the information they create.

Institutions have invested heavily in technology infrastructure. The acquisition and support of technology infrastructures are still a primary focus rather than determining how to best use technology. To some extent, technology infrastructure still determines how institutions manage and deliver information. Technology has been used to "technologize" legacy information delivery methods rather than trigger development of an information infrastructure.

A controlled publication system may have been a viable approach when authors had few alternatives to deliver information. Authors had to funnel publications through a small group of editors and graphic artists. This system is no longer viable because authors can use the WWW for delivering publications or information that might have been in publications. Faculty have numerous options for publishing information and few entities in an institution control all of the webspaces available to faculty.

Most institutions probably have little realization of how information actually flows in their institutions. The Internet has made information sharing easier and has enhanced the effectiveness of personal networks.

Authors and patrons have an expectation that information can be delivered more or less instantly. Indeed, an author with access to a Web site can make information available within minutes of completing the work. The current infrastructure may not be geared to meet those expectations.

The delays and perceived hoop jumping required of authors may make them feel they are being punished for doing their jobs. While the intent of existing systems is to assure that printed materials are of high quality, such systems may be creating an "information underground" at the institution. For purposes of this paper the information underground is intended to be the unmanaged distribution of information resources on Web sites to circumvent the institutional policies and procedures.

The quality assurance arguments are becoming less tenable as a justification for a highly controlled, publication-based infrastructure. Huge numbers of information products are produced at an institution yet few of these go through the quality assurance system. Consider most Extension Services. Extension Agents produce newsletters, handouts, presentations, news releases, radio and television programs plus other products yet few go through any of the vetting required by publication systems. Agents are also in the same position as faculty in that they have alternatives for publishing information online.

Essentially, institutions have lost control of, if not access to, the vast majority of their information products while over-processing a few, traditional publications that get delivered via the Internet. Institutions should experience a great gain in the number of information products available to them if they could better manage their information. This windfall would occur not because more products are created but because more can be found. Information products would include instructional materials, research notes, image collections, handout, presentations and virtually any other product of value.

Institutions may be at the end of the technology-centric era and now must transition to the information-centric era. This will require considerable reevaluation of current systems and a retooling to consider information management as opposed to the managing the products used to deliver information. Characteristics of the new era will be less control on information providers, a more diverse array of delivery methods, and more interoperable knowledge institutions.

The questions listed below are only offered to help structure a discussion around the state of the information environment. They are also intended to start building the list of issues each institution must address. Each institution will need to add or delete questions based on their situation or needs. To the extent they can be identified, managers of the external environment should be engaged in a similar assessment.

Management Questions

- To what extent do silos of information exist within the institution?
- Is information regarded as a primary organizational resource and managed as such?
- What are the various types of information generated throughout the organization?
- Do managers understand how information flows through the organization?
- Is the current information management system based on legacy publication management systems?
- Is the current information management system driven by technology acquisition and management issues?
- How difficult is it to actually find a document or resource without first finding a unit and person who knows where the resource is located?
- Is there a culture of information stewardship in the organization so that resources are not lost for future uses?
- How many information resources are hosted on web sites that are not the "official" organizational web site?
- Do managers know how many web sites actually store or deliver information within the organization?
- Do managers know how much of the information originating within the organization is stored or delivered on web sites outside the organization?
- Do current information management systems discourage authors or resource providers by insisting on excessive hoop jumping or by causing excessive delay between resource creation and actual delivery? If so, has this created an information underground in which authors circumvent the system thus making it difficult to find or manage resources?
- Who manages the information flow through the organization and into repositories or preservation programs?
- If an information management plan and system are developed, what training programs will be needed to assist staff in using the resulting system?
- What other organizations at the institution will be critical partners in the development of an information management plan and system?

Resource Questions

- Is there a plan or process to evaluate resources that may be lost as employees retire or otherwise leave the organization?
- How do resources get evaluated for inclusion in preservation or repository efforts?
- Are resources consistently archived, made available on line, or described in a central repository according to standard procedures and old formats become obsolete?
- Are resources saved in standard formats? Can these formats by migrated as new formats become available?
- How will resources from outside the organization or institution be evaluated for inclusion into repositories?

- How can the resources in the repository be used by students and what additional support must be provided to faculty and students to facilitate such use?
- Who decides when resources are purged from the active repository and placed in an archive?
- Are there electronic workspaces available to enhance the ability of staff to create additional resources and then move them into the repository?

Delivery Questions

- How will internal resources be kept separate from those available to external audiences?
- What standard search tools will be developed for searching single or multiple repositories?
- What level of interoperability with other institutions is desired or acceptable?

Suggested Action Steps

Develop a facilitated process that will allow institutions to conduct an information environment assessment process. Such a process will be designed to achieve a number of outcomes. The process should provide an understanding of the current information environment. Another result should be a working relationships between individuals from IT, libraries, Extension, research and instruction to facilitate development of a digital information infrastructure. Develop an action plan for the development of an information management plan.

Possible ways to achieve the assessment phase will be to have a satellite conference to provide an overview of the entire process plus details about what needs to happen at each institution.

Develop a packet or kit to assist institutions and, if funding is available, train facilitators to conduct assessment sessions. Again, if funding is available, some number of facilitators could conduct regional or institutional sessions.

Conduct workshops or conferences regarding the current information environment. Such events will provide background information but will be designed to be sufficiently controversial so as to challenge attendees to think more broadly. A desired outcome will be a more or less shared understanding and agreement about the current larger information environment and what must be done to enhance its functionality.

Provide goals or suggestions for success. For instance, what changes should occur in the institutional information environment? What will a good information management system include? What resources may have to be reallocated to the digital information infrastructure? What new skills and expertise must be developed and what new combinations of expertise are required? Does the plan treat information as the primary or one of the primary resources available to the institution?

The assessments may be of limited value if the other functions have not been developed. For instance, if an institution is ready to create an interoperable knowledge repository but the standards for interoperability are not developed, much momentum will be lost.

Institutional Information Management

The proposed solution has two major parts. One is to rethink how information is managed within the institution and shared with other institutions. The other is to re-evaluate the expectations institutions have of faculty and others who generate information products.

Instead of regulating the information production process, institutions will need to create clear expectations of authors and then provide training and support so expectations can be met. Authors must be ultimately responsible for the information they provide. They must understand the niceties of copyright, permissions and other legal issues regarding information. Information accuracy is a primary concern so authors must know when to seek reviewers and how to vet and check the accuracy of their information. Publications must be readable and be a credit to the institution thus requiring authors to write well. All of these will require a significant educational effort. However, the issues are not unique to any institution and so could be provided by a central source for a large number of institutions.

A prerequisite for successful information infrastructure development will be the revisiting of what information has value to the institution. The author suggests that what makes some people valuable as information resources is not their published work but rather their storehouse of experience and ground truth that allows them to make information valuable. How much of that knowledge can be captured during their career or shortly before retirement? How can the information vaults be mined to capture all information products, not just those intended for public distribution? What is the mechanism that would allow an institution to mobilize information about a particular subject in response to a crisis? A number of difficult questions must be considered as institutions review or develop information plans or new infrastructure.

Institutions need to stop trying to regulate information production. Instead, they must regain a leadership position by providing an information infrastructure that encourages authors to share within guidelines yet meets their needs to deliver information in a timely manner. A potential infrastructure could be Internet-based and may have the characteristics described below.

An electronic system should have, at minimum, two parts; electronic workspaces to facilitate information development and sharing among authors, and, a knowledge repository to share the information with internal and external audiences. Both the workspaces and knowledge repository could be connected to a delivery interfaces such as a portal but that would not be a requirement for the knowledge sharing system to succeed.

The shared workspaces would have a number of functions that would facilitate information creation and sharing. Such functions would work equally well for groups that were within a single institution or housed across different institutions. Specific functions include those listed below.

- Workspaces will be "owned" by individual staff members who can than create additional sub-workspaces that can be shared with other users or those with guest accounts.
- Each workspace will provide for file posting and sharing plus a discussion board and calendar. Online meeting rooms could also be added if an online meeting server is available.
- Files and workspaces will be secured and available only to those with permissions into the workspace.
- File will have version control so that multiple versions can exist in a workspace.
- Files can be locked or checked out to prevent multiple concurrent revisions.

The knowledge repository provides a number of options for information sharing. If designed properly, the repository will allow staff to share information within a more controlled environment. The functions listed below would allow the knowledge repository to achieve its information goals.

- The knowledge repository must have a thesaurus – a controlled vocabulary -- or internal schema in order assure that resources can be retrieved in a consistent manner. Ideally, schemas would be standards across all institutions to facilitate interoperability and information sharing.
- To facilitate information sharing across disciplines, the repository should allow development of multiple schemas. These could be searched individually or in total.
- Metadata records would provide descriptions of the resources that not only assisted information consumers but also those trying to manage the repository. The record could expire access to the resource on a certain date and make it unavailable.
- Faculty should have various options for sharing information. Rather than try to regulate the information creation or dissemination, the repository would provide options for information to be shared appropriately.
    - Access to each file will be governed by permissions. Those permissions are determined by the person adding the file to the repository or by system administrators.
    - Security classes can be created. At minimum, each repository would have two classes; one for internal audiences and the other for external audiences. Any resource added to the external security class would be available to the public. Additional security classes could be created so that groups could add and access resource to the repository.
- Repositories should be capable of sharing information with other repositories. Sharing can occur when metadata records are syndicated or imported and

exported between repositories. Other methods include the creation of Open Archive Initiative compliant XML from metadata records which could be shared with other inventories. Web services are also a possibility, for example, repository searches could be done from workstations using the Microsoft Office research task pane web service.

Both electronic systems will need an infrastructure to provide training and development. An entity capable of operating with multiple institutions will be required to house and oversee the infrastructure function.

The systems outlined above would provide an information centric system that focuses on information management and facilitation rather than information product regulation. Several benefits could be derived from the system.

- Faculty have better systems and choices for collaborative information creation and rapid delivery.
- Institutions have a single, centralized system that allows them to more fully utilize the information produced while having greater ability to manage the information resources.
- The ability to share the metadata records, and consequently the resources they describe, will eventually provide a national information system among participating universities.
- Once a national information management system is in place, it becomes possible to identify subjects where information is lacking or subjects where there is excess redundancy.
- A national or multi-institutional system will be better able to mobilize a greater number of information resources in emergencies.
- As a result of the educational programs, institutions will have faculty who are better able to cope with the demands of the information economy.
- Institutions will have increased numbers of information resources not because more are created but rather because more can be found.

Suggested Action Steps

Design an educational program to assure that all authors at participating institutions have the information they need to create legal information products. Writing skills require practice and mentoring but some principle could be taught via distance education. Additional educational efforts could involve information seeking skills and resources available for various subject. As new issues emerge, educational programs could provide information about resources available at participating institutions.

Develop a model for how institutions can develop information management plans. The model will include how institutions can evaluate their current situation, set information priorities, work with faculty in setting up a system, and deployment of a repository function.

Create a specification for a knowledge repository that meets the needs of participating institutions. Care must be taken to obtain the maximum functionality while allowing for ease of use and a reasonable technology footprint.

Given the specification, either send out an RFP for repository development or review options currently available on the market.

Design an infrastructure to provide continuity for repository development and to evolve the educational program.

Assure a level playing field by providing all institutions with the required expertise and/or funding to obtain repository capacity.

Maintain working relationships with others engaged in similar activities such as eXtension, ADEC and AgNIC.

Define and Develop Knowledge Repository Functions

The term "knowledge repository" is used frequently; however, it would be useful to assure that there is some base level of understanding of the term. In its simplest incarnation, a knowledge repository is simply a data base containing metadata. The metadata simply points to information that may be, and probably is, elsewhere. In this case, elsewhere is intended to mean on a server other than that hosting the metadata.

What is really being discussed is not so much the hardware/software of knowledge repository but rather repository functions. The actual application can be created in many ways with any number of software tools. The functions performed by the repository are what is most important and it is those functions on which the "searchability" and interoperability of the system relies. In addition, utilities and applications used to load the repository are as important as the interfaces that allow the repository to be searched. Consideration of the repository backend is as important as the public interface.

It's no secret that consideration of how the information is to be retrieved helps determine the design of the repository. It is less obvious how the repository assists the institution in managing information. The repository function is inseparable from the institutional information management plan and must exist within, and enhance, the information environment the institution seeks to create.

Suggested Action Steps

Recognize that the term "knowledge repository" is probably different things to different people. A second satellite conference, conference or workshop will be conducted to arrive at a confluence of understanding regarding this concept. Such a

conference would include examples of working repositories and their advantages and disadvantages. Suggested outcomes are listed below.

- Define the basic functions of an effective knowledge repository.
- Relate repository functions to the standards of interoperability.
- Emphasize that repository success is based primarily on the power of the metadata not the quantity of resources described.
- Identify the technical and information management infrastructure that will provide for the care and feeding of the repository. Does the repository assist the institution in achieving the goals outlined in the information management plan or development of a new digital information infrastructure?

Again, it is not possible for this function to succeed without consideration of the others. Repository development may be wasted effort if the current information environment is not understood and a desirable future information environment clearly defined. Moreover, one function of the repository is to leverage additional information from other institutions; consequently, its development must be in accordance to standards.

At some point, it may be helpful to have a knowledge repository showcase at a conference. Examples of repositories at institutions and those available in the private sector would be demonstrated. It will be an act of folly for each institution to develop its own repository from scratch. Selecting the best of what may be available and making it available on a system-wide or multi-institution license or agreement will be more cost effective. Resources expended on repository development will not be available to add resources to the repository.

A model repository could be developed using the current best thinking and adopting the current standards of interoperability. The model will provide information about repositories as well as demonstrate current functionality. Repository managers could be available to provide information to IT professionals, and, content managers could assist their counterparts at institutions seeking help. The model can provide a research and development function to test new concepts or tools.

Define and Adopt Standards

Standards assure that individual institutional repositories are able to interoperate and form multi-institutional, regional or national information systems. Some standards, such as Dublin Core for metadata, are well-known and easily adopted. Similarly, the National Agricultural Library Thesaurus (NALT) has been adopted as the official thesaurus of USDA. The truly difficult issues relate not to the selection and adoption of standards but rather in the use and implementation of standards.

Given these considerations, it is vital that standards adoption be accompanied by a standards implementation group. The group will provide guidance for adoption of standards and will refine how the standards are implemented.

Suggested Action Steps

Convene a standards workshop to select standards and publish or present the results. A critical additional step will be the creation of a process and structure that will periodically review the standards, answer implementation questions and clarify questions or concerns that will inevitably arise.

A group must be identified that will provide the institutional memory as to why standards were selected and the rationale as to how they were implemented. Without such a group, each time a standard is discussed or reviewed, much of the discussion will be the same as that which was lost after the standard was last considered. Some historical record will keep the process informed and streamlined.

The standards agenda would include, but not be limited to the following items.

- Metadata standards and additional guidance on how the standard will be implemented.
- Standards that allow repository interoperability.
- Thesauri identification and adoption for various broad subject areas.
- Formats for delivery and preservation of resources.
- Guidelines for sharing resources across institutions.
- Identification of hosts for backup, metadata harvesting or search tools.
- Propose a process to identify and develop collections not currently available and to add them to the resource base.

Expand Content by Developing Information Centers

Situation

The U.S Land Grant Universities with their Experiment Stations and Extension Services have served the nation well. However, it is now imperative that the nation undertake an upgrade of the information system that supports these institutions. Issues and problems that need to be addressed are listed below.

- The information economy demands not only access to information but also the capacity to share, deliver, interpret and develop information resources. In order to be effective, the Land Grant system must have the active and continuing participation of the library community.
- The current system is not interoperable. There are still silos of information based on date the institution was created, geography and organizational history.

- Recent natural disasters, potential terror attacks, changing climate and other 21st century issues have shown the system must be updated to effectively support citizens in time of need.
- There are inequalities in the system that could be remedied by assuring that all institutions have equal access to the totality of information available in the system. The system will better serve the public by having access to information contributions from all institutions regardless of size.
- The system should involve universities and other organizations that are not officially designated Land Grant. The nation needs all of its knowledge assets.

Information Centers as a Proposed Solution

The Land Grant University system is in dire need of a 21st century information infrastructure capable of augmenting its hallmark research and outreach programs and networks. A shared information management system based on university libraries and the National Agricultural Library will provide that capacity. A suitable model has been in operation for a number of years. Information centers have been used by NAL and AgNIC. The information center concept allows the development of vetted collections of information. Of equal importance is the capability of librarians or subject matter experts to assist information seekers in finding the appropriate information for their situation.

Information centers can alleviate the data slam that information seekers encounter when they use search tools such as Google. Information centers will host vetted and targeted collections. Consequently, users will begin their search in a collection that has already been narrowed to resources that are appropriate to the subject. Thus, users will not have to wade through extraneous hits that have no relationship to the subject of the search.

The information centers will liberate the vast storehouse of knowledge available in all parts of the Land Grant system. The existing digital documents and their corresponding metadata will be used to jump start information center development and to refine and improve the technology and management used in the system. However, a goodly amount of information, currently not readily available, can be added to the system.

Partner institutions can coordinate collection development efforts so as to assure emerging issues are identified and information pertaining to them is added to the system. Such coordination can provide the equivalent of an “information inventory” that will identify gaps and duplication within the Land Grant information infrastructure.

Libraries engage in preservation efforts. The digital products of preservation programs can be a valuable resource within the digital information infrastructure. Many libraries also have special collections that cover a particular subject or resource type, these can be added to the collection.

A valuable function of the library professional is the ability to do information triage on questions to determine which information is actually needed by patrons. Partner institutions have valuable experience with reference and electronic reference. Most people will find the information they search for only to find it did not solve their problem. Library professionals provide the information seeking skills and knowledge expertise to assist citizens in obtaining the information the most closely meets their needs.

Existing technologies make it possible to bring information resources to the user's desktop. Information centers could provide search tools via Web services that integrate with desktop applications such as Microsoft Internet Explorer. A user could install Web services that enable searches of desired information sources without actually having to visit the sources Website or portal. In addition, as the resource base grows, the services could be modified so create searches of greater specificity.

Information centers need not always be based in an existing library but could be created by any person or entity that has valuable information resources, the knowledge and technology to manage those resources, is willing to subscribe to information and digital infrastructure standards. An additional requirement would be an agreement to abide by any other agreements, standards or procedures that may be formulated by the digital information infrastructure consortium. Technology support could be provided by the consortium or one of the partners.

Suggested Action Steps

Review existing information center operations, determine best practices and then create an information center standard.

Identify the types of support information centers would require from the digital information infrastructure consortium. These would fall within the universe of standards created by the consortium.

Within the consortium, identify an entity that could provide coordination for information center development, subject coverage, conduct educational updates for information center personnel and other functions as necessary. An existing entity such as AgNIC, that already performs such functions, could be provided additional resources to coordinate information center development.

Digital Libraries

Digital libraries, as envisioned here, is more than traditional libraries performing traditional tasks on the Internet. Digital libraries may not have physical stacks or a building. They will consist of library professionals creating electronic resources around a particular set of subjects and then assisting patrons in the use of those resources. Rather than physical stacks, digital libraries will manage metadata that can access physical

resources of various types but housed in traditional repositories. Obviously, digital libraries will require a close collaborative relationship with traditional libraries and information center. Indeed, digital libraries may be created by consortia of information centers to provide coordinated and facilitated access to their resources.

The development of the information centers will provide some measure of order in the information environment. Citizens will be able to start their information searches in subject matter collections that are managed by librarians who can also provide reference services and conduct information interviews. However, a proliferation of information centers without some coordinating function may eventually become a problem. Information centers at institutions will probably, and should, focus on local needs. Other institutions may have the same need and so create their own information center. Creating a digital library function may provide needed coordination and could provide knowledgeable access points for citizens.

Because digital libraries are not physical entities, they can be created as necessary to meet information needs. Such needs can be centered on timely issues, response to natural disasters or related to emerging issues. However, as with information centers, unlimited proliferation of digital libraries, without some coordination, could lead to overlapping and duplicative efforts.

The distinction between information centers and digital libraries is one of scope. Information centers are envisioned as creating collections of resources around a subject and then maintaining expertise regarding the maintenance, expansion and use of the collections. Digital libraries do not necessarily creating collections but rather provide knowledgeable access to resources that exist elsewhere. To the extent that digital libraries create or identify resources those resources may be actually managed by information centers the form the knowledge cooperative that makes up the digital library.

Another distinction is that of mission. As envisioned in this paper, information centers are created in a more traditional library role and while they may make their presence known and provide on line resources, they will, in most cases, wait for patrons to come to them. Digital libraries are viewed as being more activist and frontline in partnering with Extension, outside agencies, international partners and other appropriate institution in promoting the use of their information resources to provide solutions to problems that fall within their subject expertise.

Information centers are also more likely to have a local or regional focus. Digital libraries would have a broader scope and may provide connect points for international collaborators.

Digital libraries can also “bundle” information center resources or other resources to create repositories that are national or international in scope. Having created repositories of broad scope, the digital libraries can interface with other potential resource providers or with users. Examples of digital libraries may be topics such as the impact of climate change on crop production, alternative fuels and their impact on the economy,

economic and regulatory issues associated with the North American Free Trade Agreement, and other broad topics.

Citizens affected by natural or other disasters require many things; information is one of them. A mature Land Grant information infrastructure will be able to use digital libraries to mobilize information from across the system to assist victims. The reference capability can provide information centers for disaster victims and those who are trying to help them. The infrastructure component will be able to mobilize technology assets to provide a temporary IT structure to deliver the information and facilitate communication in affected areas.

Suggested Action Steps

Convene a group to review the concept of digital libraries as described here. Determine whether the concept has merit and consider how digital libraries might function to benefit citizens and the Land Grant system.

Identify a set of existing information centers that could provide test resources for a prototype digital library and obtain funding to create the prototype as a test of concept.

Review results from the prototype or similar efforts and develop guidelines under which digital libraries would be developed within the digital information infrastructure.

Desktop Digital Land Grant

As has been stated before, electronic information resources are spread across potentially hundreds of Web sites at most institutions. Such sites may belong to individual faculty, institutes, projects, departments, colleges or the university itself. Typically, there is no uniform format or location on such Web sites to enable users to find the information more easily. While putting information on line may be easy, finding it once there is often difficult. Consequently, while more information than ever may be available it is essentially engulfed in information chaos.

Assuming the creation of a digital information infrastructure, information centers and digital libraries, a significant new knowledge delivery option becomes available. Web services can be used to allow knowledge repository search interfaces to be incorporated into browser and office applications. Such an option is currently available in Microsoft Office and Internet Explorer. Once the Web service is installed in one application it is available in all others in the office suite. When resources are retrieved by the Web service they can be viewed and text or images can be pasted into documents.

As information centers and digital libraries develop repositories, and, if such repositories conform to the infrastructure standards then an expanding list of Web services can be created. The Web service may also vet the search term against the appropriate thesaurus. Consequently, users who search for a term such as “pig” will have

the search automatically done on the preferred term “swine.” Users can install those services that search repositories covering subjects of interest to the user. Presumably, much of the unproductive searching currently done by users can be eliminated by giving them access to vetted collections. By incorporating the search tool into applications the already in use on workstations, users will not have to connect or logon to numerous Web sites to obtain needed information. The Web services option may alleviate some of the information chaos in the Land Grant system.

Institutions may benefit by restructuring their Web presence. A good deal of information delivery could be offloaded to a combination of knowledge repository and Web service. The information could be more easily found as it is described in a single place and Web sites would not need to be designed and maintained to deliver large numbers of documents. Certainly, any resources that are freed up by having smaller Web sites will be used elsewhere to add records to the knowledge repository.

As one of its functions, the consortium will need to incorporate a desktop search Web service into the development of knowledge repositories or repository prototypes. If such Web services become part of the package of standards, it will be necessary to have a registry of Web services so that users can find them and select those that are most useful to them.

Suggested Action Steps

Explore Web services as an information delivery option. Such exploration would include review of existing uses of the technology with special emphasis on applications that are incorporated into knowledge repositories.

Develop a standard for desktop Web services that are incorporated with the knowledge repository standard.

Develop a user interface for the Web service as it is displayed and functions within desktop applications.

Develop a Web services registry and support capacity within the consortium.