Report of the Workshop on Opportunities for Research on the Creation, Management, Preservation and Use of Digital Content

Supported by

The Institute of Museum and Library Services

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Through an Institute of Museum and Library Services (IMLS) grant, the University of Florida, Florida Center for Library Automation, convened a workshop in March 2003 to assess research needs related to digital cultural content. This report summarizes the results of the workshop and presents suggestions for useful areas of research.

I. BACKGROUND

The workshop was organized by a Steering Committee consisting of Bill Barnett, Field Museum; Liz Bishoff, Colorado Digitization Program, University of Denver; Christine Borgman, University of California at Los Angeles Graduate School of Education and Information Studies; Priscilla Caplan, University of Florida, Florida Center for Library Automation (chair); Ken Hamma, Getty Information Institute, J. Paul Getty Trust; and Clifford Lynch, Coalition for Networked Information. Discussions were organized around six topics: Collaboration, Interoperability, Applications and Emerging Technologies, User Studies and Evaluation, Non-Textual Formats (New Media), and Preservation. Participants were asked to read background papers including reports of earlier workshops on research needs related to digital preservation, digital library usability, digital library evaluation, collaboration and interoperability. They were also asked to submit in advance brief statements of research needs in areas of their choice.

Plenary talks by Daniel Greenstein (University of California, California Digital Library), Rob Semper (The Exploratorium) and Lorcan Dempsey (OCLC), set the stage for subsequent small-group discussions. Breakout session leaders Liz Bishoff, Tom Moritz, Rick Weingarten, Christine Borgman, Bill Barnett, Jeremy Rowe, and Robin Dale led the discussions. Breakout session results were presented to the plenary for further discussion.

Participants were encouraged to think of areas of research that could produce useful results within a 5-year timeframe, and of areas that might encourage collaboration between practitioners and researchers. There was also some interest in finding areas where the needs of libraries, historical societies, archives and museums, and in some cases public broadcasting, overlapped.

Based on prior work, the individual statements, the recommendations of breakout groups, plenary discussions, and discussions with IMLS, the Steering Committee drafted this report with its suggestions for future areas of targeted research.

II. RECOMMENDATIONS

The Steering Committee makes the following six suggestions for consideration by IMLS. The first three concern specific research areas where it is felt that IMLS should programmatically encourage proposals for applied research. The last three do not apply exclusively to research efforts, but concern IMLS funded projects more generally.

1. The integration of physical and digital experiences

The most common medium for digital experiences, the Web, presents an essentially individual and private experience, whereas the physical museum experience is a social and public experience. Even on-location digital experiences have largely replicated individual/private modes. Little is known about how to bridge digital and physical experiences to accomplish the following goals:

- improve formal education and lifelong learning,
- provide a continuity of experience,
- provide on-line and on-location experiences that mutually support and lead to each other, and
- develop a visitor experience cycle that is self-sustaining.

Suggested areas of research include:

- better evaluation of how online experiences support on-location experiences,
- how Museums can market over the web and better integrate it as a pre-visit and post-visit venue, and
- how interactive on-site digital experiences can better support an overall visitor experience.

Solving these problems is important because they are the basis for leveraging on-line experiences in a meaningful way. For museums, this research can improve learning, increase visitation, provide a programmatic and logistical justification for on-line content, and improve the ability of museums to serve as vital centers for formal and informal education.

The issues are different but also relevant in the library environment. We do not know how the use of digital library collections affects the individual as library user. Are these collections seen as extensions of the library, as replacements for it, or as wholly unrelated resources? Do they attract readers or donors to the library? Do they encourage or mitigate against the use of print and other artifactual resources? Academic and public libraries are investing substantial resources in building web-accessible collections. It is important to know how these sites affect the expectations of users, and how they can be used to establish a closer relationship between the institution and the individual.

2. Knowledge organization

Libraries, archives and museums are rich in tools for knowledge organization. We have a wealth of both general and specialized thesauri, gazetteers, and classification systems.

There has been substantial activity in exploring newer forms of knowledge representation such as ontologies, topic maps, and semantic Web components. Overall, however, neither traditional nor emerging semantic tools have been exploited to their full potential in digital libraries. Thesauri, for instance, are more often used as tools for assigning index terms to documents than as entry vocabularies or aids to search construction for end users. The CIDOC Conceptual Reference Model [see http://cidoc.ics.forth.gr/] is only beginning to inform individual applications despite its potential for integrating retrieval across heterogeneous systems.

Research is needed in three areas specifically:

- how can the tools of knowledge organization be used to improve the user's experience in searching, retrieving, navigating and comprehending digital collections?
- how can they be used to enhance metadata, particularly the minimal metadata that may be extracted automatically from some digital objects?
- how can they be used to increase interoperability among disparate systems and collections?

This research is important not only to leverage the considerable investment the community has made in the creation and maintenance of knowledge organization tools and to evaluate the likely benefit of future investments, but also to leverage investment in digital collections and services themselves. The web environment is fragmented and opaque; searchers do not always know what collection they are using, much less its rules for indexing and vocabulary control. As old rules for training users in local practices become less applicable, using the tools and techniques of knowledge management is the most promising approach to improving the educational and research capacity of our digital collections.

3. Digital preservation

A critical component of digital preservation infrastructure is the existence of a sufficient number of trusted repositories capable of storing, migrating, and providing access to digital collections. Currently, this critical component is lacking. A small number of institutions have working repositories; a greater number are researching and planning for future digital repositories. Compounding the infrastructure problem is a lack of diversity in existing and planned repositories – most repositories are being executed on behalf of large, individual universities and national libraries. Few address the needs of smaller cultural heritage institutions/organizations - those least economically capable of building local repositories (even though these same institutions have been very successful at obtaining digitization funding over the last five years). A majority of institutions have little hope of building local, trusted digital repositories though few alternatives currently exist. Little is known about whether tools built for other communities will be applicable or will adequately address the needs of different kinds of institutions and user populations. Additionally the technical expertise to implement a preservation repository system is likely beyond the capabilities of the smaller institution who is more than capable of undertaking a digitization project.

Suggested areas of digital preservation research include models for trusted digital repositories; models for the establishment of cooperative repositories; digital repository service needs, especially how they might differ across user communities; attributes of digital objects that must be preserved; and risk analysis with variables relating to metadata, file formats, rights and permissions, and other critical factors. Also needed are economic models for preservation. The Mellon Foundation has identified some approaches to addressing economic issues in preservation such as the "tragedy of the commons" and the "free rider" problems. Intellectual property regimes also are a significant barrier to preservation and access. Initiatives such as the Creative Commons [see http://www.creativecommons.org/] should be encouraged and explored for libraries, museums, and archives. The establishment of a network of trusted digital repositories is critical to protect the investment being made in the digitization of our cultural heritage, as well as to preserve the ever-growing amount of materials which are born-digital and have no analog back-up. Decision models, risk analyses, and other tools are crucial components of the required infrastructure and are needed to document and support the range and choices of preservation strategies.

4. Reporting

In many areas, simply extracting and consolidating information that is already known would be of great benefit. For example, the IMLS has funded a substantial number of collaborative initiatives through its Library-Museum Collaboration program. Collaborations between U.S. cultural heritage institutions and schools, historical societies, public media, commercial enterprises, and institutions in the developing world are likely to have widely different characteristics. If reports of all types of collaborations were gathered, analyzed, and made available for data mining, this would shed light on incentives to collaboration and on factors that influence the effectiveness, cost-effectiveness, and sustainability of collaborative endeavors. Similar cases can be made about the results of user studies, experiments in interoperability, and applications of new technologies.

Grant reporting requirements could serve as a vehicle for beginning to address this issue. As a first step, IMLS should think about how its reporting requirements could be leveraged to facilitate current and future analysis by creating easily accessible databases of similarly structured summary information. In the longer term, earlier reports and work funded by other sources could be included. Ideally, all funding agencies relevant to digital library, archive and museum initiatives would participate by contributing to a central (or centrally searchable) store of project reports.

5. Evaluation

A variety of types of evaluation are needed for libraries, museums, and archives. Most important is iterative evaluation and design. More projects should begin with formative evaluation of user needs and organizational needs that can be incorporated into the design process. All too often, the little evaluation that is done takes place at the end of the

project, at which time it is too late to have much effect. Evaluation of individual projects is useful if it leads to improvements in those projects and to broader lessons that can be applied elsewhere. Evaluation of programs also is needed. Programmatic evaluation should address the success of a program in regard to its stated goals and to its impact on the target community. Individual libraries, museums, and archives tend not to have the skills or capacity to conduct formative, iterative, or summative evaluation, however. IMLS initiatives could be directed at capacity building via workshops or academic programs. Evaluation experts could be involved in programmatic evaluations.

Current grant projects require summary evaluation according to an outcomes-based model. However, despite a significant amount of resources that have gone into the summary evaluation of individual projects, the barriers to meaningful outcomes-based evaluation are high. Some projects can best be evaluated after some period of operation, which puts the optimal time for evaluation beyond the funded period. In many of the digitization projects particularly, the grant period includes time for the creation of the content and the website, not the time for end user behavior to change or learning to take place. Other projects do not lend themselves to outcomes-based techniques. More emphasis should be placed on formative, iterative evaluation for individual projects, while large scale summary, outcomes-based evaluation is appropriate for measuring the impact of funding programs.

6. Balance

The workshop has shown very clearly that research needs are many and that practitioners are eager to take advantage of research results. At the same time, research must be seen as part of a larger portfolio of activities necessary to advance the needs of the community. Other needs include advancing standardization activities, encouraging technology transfer, and building basic infrastructure. Community building is essential, and is fostered by meetings such as this, which bring together researchers, practitioners, and representatives of libraries, museums, archives, library education, public broadcasting and related domains. The Coalition for Networked Information, the Digital Library Federation, the National Science Digital Library, the Joint Conference on Digital Libraries, and other organizations and initiatives have been important in shaping the digital library community and providing avenues for communication and consensus-building. However there is no other institution in the U.S. with the constituency of the IMLS, embracing scholars, researchers and practitioners from this range of cultural heritage institutions. The IMLS should develop a balanced agenda of funding that integrates basic and applied research, services, and community-building activities. IMLS should continue to sponsor workshops and meetings that provide a forum for discussion, a locus for community-building, and an opportunity for busy people to take time out to reflect on hard problems.

III. REPORT OF BREAKOUT DISCUSSIONS

Collaboration

Collaboration is more than cooperation. The primary purpose of a collaborative is to accomplish more, more effectively, than any of the participating institutions can do individually. Collaboration requires a shared problem and goal, and must advance the mission of all participating organizations. Participating institutions must retain their own identities and their ability to make strategic decisions. Because all participants need to perceive the rewards of collaboration, collaborations are often more successful among dissimilar institutions, where each partner can maintain "boasting rights" within its own community.

The current environment rewards competition rather than collaboration. Therefore understanding the reward system in libraries, museums and other cultural heritage institutions is important to understanding what incentives do or could do for encouraging collaboration. It is also important to understand the factors that lead to successful collaborations. We have made the assumption that collaboration is worthwhile, while at the same time we know that collaborative initiatives can be a drain on institutional resources. There should be a programmatic review and analysis of the outcomes of previously funded collaborative initiatives in terms of their costs and benefits. What collaborations have been useful and cost-effective; what are their characteristics? What is the impact of involving different types of organizational partners, such as the private sector, or resource-poor institutions such as schools?

Collaboration could be encouraged by developing the infrastructure to support it, such as interoperability standards and tools. A U.S. national digital library or metadata repository may or may not be feasible, but a discussion of what this would require would be useful, and could point to social, economic, and technical infrastructure developments that would aid other collaborative efforts.

Collaboratives need norms and a vocabulary for addressing issues of ownership, not only of digital content but of all of the assets of the collaborative. What models exist for the allocation of ownership and for the division of responsibility? If a collaborative is formed for a particular project or initiative, what takes place after the formal end of the initiative? Acknowledging there are multiple approaches to these issues, the community would benefit from case studies, model agreements, and ultimately from best practices documentation.

Issues related to the fact that different user groups have different needs are particularly relevant to collaboratives, where participants are likely to be different types of institutions with significantly different user bases. Content will be underused if we cannot make it possible for people to use it in different ways.

Interoperability

Breakout groups focusing on interoperability spent some time developing working definitions of the concept that were not exclusively technical but included the ideas of users and use. Interoperability supports the exchange of information, objects and services among systems, but must do so in a user-centric way, supporting the full range of information seeking behaviors and applications.

Like collaboration, interoperability has costs and benefits, which is a research area in itself. How do we measure interoperability? How do we quantify the cost of not finding information? Any metrics that are developed have to take into account user perceptions, and have to treat interoperability as a continuum rather than a yes/no proposition. When is interoperability good enough from the user perspective? Much of the technical basis for interoperability lies at the level of infrastructure rather than in high-level services. Investment in infrastructure is a common good, but what are the opportunities to invest in infrastructure and what are the incentives? How do these vary across communities?

Interoperability relies on standards, but many of the standards in the digital library arena are suspect in terms of their quality, applicability and durability. How do we develop and implement robust standards? What causes some standards to die out and others to persist? What is the place of "community standards"? Neither libraries nor museums can be said to be a single community but rather include many communities, all developing their own independent standards. Is interoperability better addressed by encouraging common standards or by developing middleware that supports multiple existing standards? A specific research project might develop and/or test agents that are capable of addressing multiple standards not known to the agent in advance.

The creation and sharing of metadata provide the foundation for certain types of interoperability. Generalized studies are needed into how cultural heritage institutions create and use metadata, and how they could create better metadata that meets both local needs and the requirements for high-level interoperability. How do institutions select and implement metadata schemes? Does this vary in institutional and collaborative contexts? Can web-based knowledge organization tools be used to automatically improve metadata and to extend its usefulness across domains? What is the utility of aggregated metadata, and how can this be measured?

Two of the plenary speakers suggested architectural frameworks to support interoperability. However, moving from our current "siloized" systems to more interoperable repository architectures will take a huge investment that is not likely to be made without a clear sense of the workability and benefits of these architectures. This in turn requires testbeds and demonstration applications. Specific research projects should develop a testbed of four or five repositories and build systems over them. Which core web services are required? Which architectures are best suited to working interoperability?

Interoperability is impeded by issues of intellectual property. Beyond institutions wishing to protect revenue streams, the Digital Millennium Copyright Act has made it hard to link to objects and to share them. Studies of cost and income streams can document what will not generate revenue and ought to be in the public domain.

Applications and Emerging Technologies

This is an area where participants appeared to fall into two camps with somewhat different perspectives. To some, new technologies were seen as a means of addressing existing problems, and were judged useful to the extent they provided solutions. To others, new technologies opened up realms for new applications and services, and were evaluated based on promise.

Technologies felt worth exploring for their potential to address existing problems include web services, digital asset management systems, and tools for knowledge organization such as taxonomies and ontologies. Knowledge management tools are also of interest in relation to automated metadata creation and image digitization. Technologies holding particular promise include those that can help extend the patron experience before, during and after a visit; capture technologies for video and other new media; and human language technologies such as speech recognition. Research and demonstration projects in all of these areas should be encouraged.

Discussion of emerging technologies raised questions about what we really know about the characteristics of museums and libraries, and where these differ in their cultures of organization and in their approaches to information handling. If common perceptions are true, libraries have more cultural disposition to collaborate and more practical experience in developing and implementing standards, while museums have been quicker to understand and adopt multimedia and interactive technologies. Possibilities for shared application development should be encouraged, as each community has a lot to learn from the other. Libraries and museums working together might also have more influence over the research and commercial sectors in developing tools both communities need, such as tools for dealing with very large digital objects.

Technology transfer is a particular problem and a potential research area – given so much that is new and possibly of use, how do practitioners stay ahead of the curve? How does the community appropriately define a role for its application vendors as partners in this effort and in research? It was strongly felt that libraries and museums should be more directly involved with technology creation, with influencing commercial development, and with high performance computing initiatives, such as Internet2. Applications and emerging technologies are unlikely to suit the needs of the cultural heritage sector without visible and vocal participation from that sector.

User Studies and Evaluation

User studies and evaluation were organized as one working group, although they are distinct topics. Users of digital libraries may be studied for the purposes of

understanding human behavior in information-related tasks, including seeking, using, and creating information in many media. Evaluation of digital library systems and services is but one purpose of user studies. Similarly, usability is but one purpose for digital library evaluation. Digital libraries also may be evaluated for the efficiency, cost-effectiveness, maintainability, service quality, and a variety of other purposes. Evaluation of digital libraries was the topic of a recent European Union-U.S. workshop, as it is a concern of funding agencies on both continents [see the conference report at http://www.sztaki.hu/conferences/deval/presentations/final_report.html]. .

Digital libraries have become an essential foundation for areas as diverse as electronic publishing and museum asset management, and serve as a primary means to deliver content for scholarship, commerce, cultural heritage, and education. Networked information systems are now an ubiquitous component of business, commerce, community, and education. Despite these advances, we have little understanding of the effectiveness of digital library systems and services in supporting these essential aspects of daily life in the 21st century.

Digital libraries support specific activities in specific contexts – classroom instruction, distance learning, digital asset management, scholarship, virtual museums, and so on. Digital libraries need to be evaluated as systems and as services to determine how useful, usable, and economical they are and whether they achieve reasonable cost-benefit ratios. Not only must expenditures of organizations providing digital libraries be considered, but also the time of users. We must assess the *value* that users receive from these systems. Results of evaluation studies can provide strategic guidance for the design and deployment of future systems and can assist in determining whether digital libraries address the appropriate social, cultural, and economic problems. Consistent evaluation methods also will enable comparison between systems and services.

Evaluation research can be a highly applied form of investigation, or it can test theory. Evaluation research is particularly useful for studying aspects of communication technologies such as interactivity, adoption, use, implementation, and social impacts. Evaluation itself can be cost effective, particularly in areas of usability. Even a small amount of usability evaluation in the development of information systems can pay for itself several times over in cost savings from lost productivity.

Discussions of this breakout group and in subsequent plenary discussions established the need for research and development in the areas of measures and metrics for user studies and evaluation, and for building capacity in the field of library, information, archive, and museum studies. Several specific recommendations for action by IMLS were proposed:

- Evaluation mechanisms should be embedded in new digital library projects.
- Research on methods and metrics for digital library evaluation should be seeded through specific grants.
- Programs of research should be evaluated as well as specific digital library implementations.

- Instruction in evaluation for practitioners and for graduate students should be seeded via instructional development grants, workshops, and other programs
- Results of these efforts should be promulgated widely. Measures and metrics should be packaged in ways that they can be implemented by practitioners in the field.
- IMLS should cooperate with other agencies who fund evaluation research on digital libraries, such as the National Science Foundation and the European Union DELOS.

Several measures of success were identified, including: the number of courses in evaluation methods taught in library, information, archive, and museum studies, and number of students per course; the number of new job descriptions posted that include evaluation studies as a duty; the number of studies conducted and published in the literature of library, information, archive and museum studies; the assessment of investment decisions in digital libraries made on the basis of evaluation studies; the measurement of system improvements based on evaluation studies; and the measurement of success of digital library programs.

Non-Textual Formats (New Media)

New media includes non-textual formats such as images, audio, video, multimedia, geographic information systems, multi-dimensional objects, software code, and immersive environments. Although museums and libraries embrace new media, their properties are not well understood, raising issues of capture, storage, management, presentation, preservation, and intellectual property.

Research related to new media is inherently practical in nature. Simply identifying and piloting applications of new media is a high priority, in order to define ways of developing, storing and using these materials in different contexts. Pilot user interfaces to new media must be developed that work not only as client applications inside the museum or library on high-bandwidth networks but also as browser-based applications for remote users with slower connectivity. A *New Media Technology Watch* should be published as a means of monitoring tools, costs, evaluation criteria, strategies and best practices for implementation and use of new media.

The identification and documentation of significant properties is also particularly important for new media. How do we retain the authenticity of the user's experience after preservation actions (emulation or migration) or through the creation of derivative works? What elements of look and feel must be preserved, and which can be lost without damage to the object's conceptual intent?

Research is also needed into the management of complex objects, including storage and access strategies, version management, and linkage maintenance. Intellectual property management is poorly understood in areas such as interpretation of the law, how to obtain permissions, how to license collection content, how to license component materials, and how to relicense external content.

Preservation

The report of a 2002 workshop sponsored by the National Science Foundation (It's About Time: Research Challenges in Digital Archiving and Long-term Preservation) laid out a research agenda for digital archiving and long-term preservation [see the workshop report at http://www.si.umich.edu/digarch/Report.DFt.2.doc]. This report includes specific research questions related to the attributes of digital repositories, the attributes of archived collections, archiving and preservation tools and technologies, and policy and economic models.

Rather than reinventing or reconsidering these priorities, it would be more productive to investigate where the cultural heritage communities has special needs or perspectives in relation to these priorities. Also, given that work is already being done to address some of the research questions posed by the NSF report, IMLS should look for partnership opportunities.

A priority within this framework is assessing the attributes of digital objects that must be preserved. More work is needed on the possible significant properties for different classes of digital materials and how these properties in turn determine the underlying technical form or structure to be preserved and the necessary technical metadata. How can we select and preserve complex digital objects? Should tools be developed to enable creators to identify significant properties at the point of creation?

Risk analysis with variables relating to metadata, file formats, rights and permissions, and other critical factors is also needed. The preservation paradigm has shifted from a guarantee of preservation to risk assessment. Along with risk assessment, decision models and tools are needed to support the choice of preservation strategies. A key research area is the development of metrics to measure the quality and fidelity of digital objects before and after preservation processes, such as reformatting.

Working preservation repositories are needed to test various models in terms of preservation strategies, repository architecture, and media formats. Repositories and service models must be established to serve the needs of smaller organizations and institutions without the means to develop their own preservation facilities. Many smaller institutions will need guidance in how to think about digital preservation, how to analyze their options, and how to minimize risk. While not a research issue *per se*, accumulated knowledge should be codified in an accessible way and made widely available.

Summary of themes

Several themes and key issues that cut across breakout topics arose from these discussions.

Significant properties of digital objects. Ascertaining and documenting the significant properties of an object are critical to the use, management, documentation and

preservation of the object. Significant properties may be functional or conceptual, and are not well understood. What characteristics of an object must be maintained through different delivery systems and preserved over time? What metadata is needed to document conceptual intent and authenticity of look and feel? Is it possible to develop a framework for categorizing significant properties of new media? For individual objects such as works of digital art, the creators and viewers/users of the object may be the only authorities on its significant properties. How can this information be captured? What can be said about its reliability?

The ecology of standards. Standards are vital to interoperability, persistence, and collaboration, but their implementation requires considerable time, effort and expense. To ensure the investment is worthwhile, we want standards that are appropriate, widely-used, well-maintained, and not likely to be marginalized or superseded in the short term. While the museum community suffers from a dearth of appropriate standards, the library community suffers from a plethora. We seem to be proliferating standards within a small community without a clear economic model to support them. What organizational and financial models for standards maintenance are most likely to ensure that standards remain robust? What factors contribute to the development of specialty standards with narrow applicability, leading to the "siloization" of standards? Are registries and crosswalks effective tools for dealing with multiple standards generically? Are there other approaches?

Rights and intellectual property. Research, applied research, and guidelines are needed relating to all areas of this topic. Collaborative projects would benefit from case studies and surveys of how ownership rights are allocated in a collaborative and from model rights agreements. Collection managers need pilot projects that improve their understanding of licensing for complex objects, including whole objects and component parts, and relicensing of external content. We need to understand how to use digital asset management tools in a way that preserves fair use, copyright and privacy policies. We need studies to understand the effect the Digital Millennium Copyright Act has actually had on collection digital development, interoperability, collaboration, and use.

Characteristics of libraries, museums and their users. It is a truism that libraries and museums have different cultures, but there appears to be a need for factual information documenting the similarities and differences between these institutions and their users. Do libraries and museums have the same incentives and disincentives for collaboration and interoperability? As these institutions rely more and more heavily on their web presences, are core functions beginning to overlap? What is the crossover between users of art museums, natural history museums, archives and libraries? How are these audiences the same and how are they different? What are the differences in user expectations of these institutions?

Tailoring services to user groups. There was strong agreement from all sectors that different sets of users have different needs. User studies could help to demonstrate differences between user groups both in terms of their information needs and in terms of the variables that provide group identification. Demonstration or pilot projects would be

useful as a model of how to provide different services to different groups over the same collection base. How do we provide specialized services while maintaining a user's privacy? Do the same architectures that support the delivery of customized services also support inter-system interoperability?

Evaluative reviews. There have been many efforts at collaboration, interoperability, and implementation of new technologies and new media. Overall, however, the community lacks a sense of what works and what doesn't. For example, what factors are associated with successful and unsuccessful collaboration in digital exhibiting or collection building? Projects already funded by the IMLS might provide a starting place for surveying participants, developing measures of success, and doing a systematic analysis across many cases. As digital preservation initiatives mature, this might also be an area for review and evaluation.

Higher level models. The digital library community lacks a commonly accepted architectural model, similar to the Sharable Content Object Reference Model (SCORM) adopted by the educational community, or the Open Archival Information System Reference Model (OAIS) for digital archiving. We need to further consensus-building around high level models, and encourage the development of testbeds for them. An emerging model posits that metadata and data objects should reside in standards-based, content-neutral repositories, allowing higher-level services to be layered on top of them. Projects should be funded that test services and agents that work across repositories, and that implement mechanisms for mapping between different metadata schemes and different standards and protocols.

Beyond research. As is evident from this report, the research "wish-list" is very long, with many competing priorities. One question not adequately addressed at the workshop is, "Who will do this research?" Will it take place within individual libraries, museums and archives, or can university faculty and other researchers be involved as research partners? The partnership between academic and institutional researchers still needs to be addressed. In addition, it is clear that answers to research questions will satisfy only a subset of the needs of the community. There is a need to simply find out what *is*, through case studies, surveys, and better mechanisms for both formal and informal communications. There is a great practical need for the development of a better standards infrastructure, a preservation infrastructure, and a communications infrastructure. The cultural heritage community needs forums for communicating practice and best practices, and opportunities to get together in multicultural groups to share information. Perhaps above all, the community needs funding not only to do, but to think collectively on larger questions such as architectural frameworks, taxonomy modeling, and value transmission. IMLS needs to develop a balanced agenda of funding that integrates basic and applied research, services, and community-building activities.

IV. WORKSHOP MATERIALS

Plenary presentations

Presentation by Lorcan Dempsey, Interoperability: Recombinant Potential (ppt)
http://www.fcla.edu/~pcaplan/IMLS_Dempsey.ppt

Breakout sessions

Applications and Emerging Technologies Breakout Session Summary (ppt)
http://www.fcla.edu/~pcaplan/IMLS_Applications.ppt

Collaboration Breakout Session Handout (doc)
http://www.fcla.edu/~pcaplan/IMLS_Collaboration.doc

Collaboration Breakout Session Summary (ppt)
http://www.fcla.edu/~pcaplan/IMLS_Collaboration.ppt

Evaluation Breakout Session Handout (doc)
http://www.fcla.edu/~pcaplan/IMLS_Evaluation.doc

Interoperability Breakout Session Handout (doc)
http://www.fcla.edu/~pcaplan/IMLS_Interoperability.doc

Interoperability Breakout Session Summary (ppt)
http://www.fcla.edu/~pcaplan/IMLS_Interoperability.ppt

Non-Textual Materials (New Media) Breakout Session Summary (doc)
http://www.fcla.edu/~pcaplan/IMLS_Newmedia.doc

Preservation Breakout Session Handout (doc)
http://www.fcla.edu/~pcaplan/IMLS_Preservation.doc

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