Variations as a Testbed for the FRBR Conceptual Model

1. Assessment of Need

In November 2006, the Library of Congress commissioned a working group "to examine the role of bibliographic control and other descriptive practices in the evolving information and technology environment, and to make recommendations to the Library and to the larger library community."[1] This body, named the Working Group on the Future of Bibliographic Control, released a final report on January 9, 2008[2]. A great deal of discussion has revolved around the report's recommendation 4.2.1: Develop Test Plan for FRBR. The Working Group's report states that while the Functional Requirements for Bibliographic Records (FRBR)[3] conceptual model holds a great deal of promise for transforming how libraries conceptualize and describe materials in order to provide more useful discovery service for our users, "until carefully tested as a model for bibliographic data formation for all formats, FRBR must be seen as a theoretical model whose practical implementation and its attendant costs are still unknown.[4]" While the Working Group's report addresses its FRBR-related recommendations to "LC, OCLC, IFLA Working Group, and Representative System Vendors", the library community as a whole can also contribute significantly to a FRBR test plan. Indiana University is in a unique position to provide a metadata creation and discovery environment for FRBRized bibliographic data, along with raw versions of that data for use by others, in a reasonable time frame.

The FRBR conceptual model presents "an entity-relationship model as a generalized view of the bibliographic universe.[5]" It defines three groups of interest: Group 1 Entities (Work, Expression, Manifestation, and Item) are the products of intellectual or artistic endeavor, Group 2 Entities (Person, Corporate Body) are those responsible for intellectual or artistic content, and Group 3 Entities (Concept, Object, Event, Place) serve as the subjects of Works[6]. The FRBR report also defines four user tasks supported by the Group 1, 2, and 3 entities: Find, Identify, Select, and Obtain, which can operate on the defined entities, therefore offering more flexibility in the types of services we can provide on bibliographic data. At the time of this writing, however, no (even de facto) standard, formal data model exists that can be used as the basis for a system implementation of the FRBR conceptual model.

The IMLS-funded Variations3[7] digital music library project at Indiana University, as described below, has been actively investigating the utility of FRBR for representing bibliographic data for music since the beginning of the project in October 2005. Our newly proposed project would continue this work after the Variations3 project officially ends in September 2008 by putting into production a fully FRBRized model underneath the Variations music discovery and delivery system, which is currently Work-based but not FRBR-compliant. IMLS funding for the proposed project would allow Indiana University's technical plans to move forward, creating a more sustainable, standards-based system, and at the same time demonstrate in a practical way the utility of the FRBR model for bibliographic data at a reasonable scale.

Musical materials are an ideal test case for the FRBR model, as they represent Works that tend to have multiple Expressions and Manifestations. Experiments done on full library catalogs are likely to be overwhelmed by the estimated 78% of works that exist in a single Manifestation, [8] making it difficult to study cases where the FRBR model provides the most benefit for discovery. The Variations system, with its exclusive focus on musical materials,

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[1] http://www.loc.gov/today/pr/2007/07-244.html

[2] "On the Record: Report of The Library of Congress Working Group on the Future of Bibliographic Control." http://www.loc.gov/bibliographic-future/news/lcwg-ontherecord-jan08-final.pdf

[3] IFLA Study Group on the Functional Requirements for Bibliographic Records. *Functional Requirements for Bibliographic Records.* Munich: K.G. Saur, 1998, http://www.ifla.org/VII/s13/frbr/frbr.pdf

[4] "On the Record," p. 33.

[5] Tillett, Barbara. "What is FRBR? A Conceptual Model for the Bibliographic Universe." Library of Congress Cataloging Distribution Service, 2003, http://www.loc.gov/cds/downloads/FRBR.PDF.

[6] FRBR Report, Section 3.2, http://www.ifla.org/VII/s13/frbr/frbr.pdf

[7] http://www.dlib.indiana.edu/projects/variations3/

[8] Bennett, R. et. al. (2003) "The Concept of a Work in WorldCat: An Application of FRBR," *Library Collections, Acquisitions & Technical Services* 27, 45-59.

can provide a testbed that both allows evaluation of the separation of bibliographic data into FRBR Entities and cataloging interfaces for the streamlined creation of this data. The Library of Congress Working Group on the Future of Bibliographic Control has issued a challenge to the library community to create exactly the type of testbed we propose. As part of this project, we will both pursue formal evaluation of our FRBRized system and make that system and the data that drives it available to the library community for further independent testing.

We expect that the work of this project will be of interest to several different but overlapping communities within the Library and Information Science sphere, including those studying and planning for next-generation library catalogs, specialized music libraries, music information retrieval researchers and practitioners, and LIS researchers studying bibliographic data models and innovative discovery systems, in addition to the communities encouraged in the Library of Congress Working Group on the Future of Bibliographic Control report to develop a test plan for FRBR: the Library of Congress, OCLC, the IFLA FRBR Review Group, and ILS system vendors.

2. National Impact and Intended Results

A FRBRized system on the scale of Variations, providing discovery services for the entire audio recording and score collection held at IU's William and Gayle Cook Music Library (currently approximately 80,000 MARC bibliographic records for audio recordings and 105,000 records for scores and parts) would present an opportunity for real-world testing of a data model that realizes the FRBR conceptual model. Unlike much of the previous work implementing FRBR, this system will be openly available for community examination, operate in a production environment, and be based on a concrete data model that is both documented and shared. This project will develop such a model, if none emerges before the project begins, and disseminate its specifications widely so that other FRBR implementations can build upon them.

Much of the uncertainty surrounding the FRBR model concerns its complexity, especially as compared to the current bibliographic infrastructure in libraries. This complexity is necessary in cases where Works appear in many Manifestations, a common occurrence in the field of music. Yet if a cataloging or discovery interface were to show this complexity at all times, even for Works that appear only in one Manifestation, the cataloger and end user would both quickly become overwhelmed. Our proposed project will contribute to the state of the art in utilizing FRBR by creating interfaces for both cataloging and end-user searching that make full use of the complexity of the FRBR model when necessary; yet mask this complexity when it is not needed. This project proposes to not just design but also to *assess* user interfaces for cataloging and end-user discovery of FRBRized data. We will perform user testing based on common cataloging tasks and actual music student and faculty discovery needs to evaluate the effectiveness of both the FRBR conceptual model and the interfaces by which these two groups interact with FRBRized data.

The initial population of data into the newly FRBRized Variations system will be through the conversion of MARC Bibliographic and Authority records into the FRBR data model. Due to the fundamental conceptual differences underlying the FRBR and MARC/AACR2 models, however, this method will only be partially effective. We will use the newly-redesigned Variations cataloging interface to manually edit the FRBRized records, and create new ones from scratch. Estimated costs for each of these activities will be tracked and made available to help inform decision-making in relevant communities about the costs associated with a large-scale move towards FRBR for bibliographic information. Our proposed project will involve creating records and estimating costs for FRBR Group 1, Group 2, and Group 3 Entities, including attributes defined for each of those entities in the supplemental Functional Requirements for Authority Data (FRAD) report[9], going beyond most other FRBR implementations that have focused only on Group 1 Entities, or even only on Work and Manifestation. Records created according to each of these methods will also be made available to the community for further testing. We believe this work will not only make available a methodology for converting existing MARC/AACR2-based records into a FRBRized model, it will also demonstrate in a concrete way how effective such automated means can be, and show the extent to which a new FRBR-based bibliographic infrastructure can maintain backwards compatibility with the current one.

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[9] IFLA Working Group on Functional Requirements and Numbering of Authority Records (FRANAR). *Functional Requirements for Authority Data: A Conceptual Model.* Draft, 2007-04-01, http://www.ifla.org/VII/d4/FRANAR-ConceptualModel-2ndReview.pdf

The Variations system also offers another benefit for studying the future of library systems, in that it provides an opportunity for testing how the FRBR model can be made to support or interact with systems that provide user tasks beyond those it originally identified—Find, Identify, Select, and Obtain. Variations not only provides *discovery* services but also *use* tools. Authorized users of the system can follow links to view scores or listen to audio files from the collections of the IU William and Gayle Cook Music Library. The system then allows those users to interact with the material, annotating it, placing a timeline over a graphic representation of an audio file, building a playlist, and self-quizzing to prepare for an exam, along with other functions. To support these tools, our project will provide a model for how the descriptive metadata-focused FRBR model can be used together with structural and administrative metadata standards.

3. Project Design and Evaluation Plan

Status of Variations at the Start of this Project

The Variations system at Indiana University has a long history, with its beginnings in the Cook Music Library as a tool for streaming audio in 1996 and the addition of scanned score images shortly thereafter.[10] Indiana University then undertook a large-scale research and development project funded by the National Science Foundation from 2000-2005 called Variations2. [11] The Variations2 project was organized around several research areas: copyright, metadata, music instruction, networking, system design, and usability. Our investigations in each of these areas fueled our work expanding the Variations system to provide tools to use musical content in instruction and research, and designing a Work-based metadata model.[12] While the Variations2 metadata model is similar in many ways to FRBR, it is not explicitly a FRBR implementation, and carries a number of significant differences, including a more concrete definition of a Work, treating the same performance on two different distribution media as separate entities, less robust handling of multiple copies of the same item, and assuming all materials in the system are available for online delivery.

The most recent phase of Variations, known as Variations3, is an IMLS NLG-funded project with two major goals: to update the Variations software so that it can be installed and used effectively at institutions other than Indiana University, and to test methods for making metadata creation for the system economically feasible[13]. The overarching theme of our Variations3 work agenda was to make changes to the system that would make it more sustainable over the long term. Our Variations3 proposal included a task to make recommendations for how the Variations data model could be adjusted so that it aligned better with the FRBR conceptual model. In September 2007, the Variations3 metadata team released a report outlining how the FRBR Group 1 entities could be applied to musical materials.[14] Based on this report, the project team determined that moving the Variations system to a fully FRBR-compliant model could not be done with incremental changes to our existing system; instead, the data model would have to be re-implemented from scratch. Such an activity was outside the scope of the Variations3 project, and our team has turned our FRBR-related efforts towards additional formal planning for this change, rather than system implementation.

By the official end of the Variations3 project in September 2008 (we plan to request a no-cost extension to complete some other project activities, however), we expect to have the bulk of the planning work for a full FRBR implementation in the Variations system completed. Before the proposed project begins, we will have performed each of the following tasks as part of Variations3:

1. Extend our analysis of FRBR for music to include the Group 2 and 3 entities, and FRAD concepts.

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[10] http://www.dlib.indiana.edu/variations/
[11] http://variations2.indiana.edu/research/
[12] Harriette Hemmasi. "*Why Not MARC?*" International Conference on Music Information Retrieval, Paris, France, October 13-17, 2002, http://variations2.indiana.edu/pdf/hemmasi-ismir2002.pdf
[13] http://www.dlib.indiana.edu/projects/variations3/
[14] Riley, Jenn, Caitlin Hunter, Chris Colvard, and Alex Berry. "Definition of a FRBR-based Metadata Model for the Indiana University Variations3 Project." September 10, 2007, http://www.dlib.indiana.edu/projects/variations3/docs/v3FRBRreport.pdf.

2. Develop or adopt a FRBR data model. We will analyze existing attempts to implement the FRBR conceptual model as a formal data model, including FRBRoo[15], FRBR in RDF[16], the Music Ontology[17], and any alternatives that may emerge before the end of the Variations3 project, and evaluate them in terms of their ability to represent the FRBR Entities and FRAD concepts needed for FRBRized Variations data, their long-term sustainability, their fitness with our existing technical architecture, and the ability to support a relational/object oriented database structure as envisioned for future library catalogs by the Joint Steering Committee for Revision of AACR[18]. If none of these meet our requirements, we will develop and share openly with the community a new FRBR data model, including a data dictionary and data storage format (likely an XML or RDF Schema).

3. A FRBRization algorithm for mapping MARC Bibliographic and Authority records to the new Variations data model. The Variations system has since the days of Variations2 had methods for converting MARC Bibliographic and Authority records to the work-based Variations2 model, but the full Variations cataloging process still required a great deal of manual intervention. As part of the Variations3 project, we have been conducting iterative testing of algorithms for the batch loading of data, and are encouraged by early results. Before the end of the Variations3 project, we will stabilize and make publicly available these algorithms, which improve on existing published algorithms from the Library of Congress and OCLC by more effectively handling multi-Work manifestations. The algorithms we publish will convert MARC data into current Variations data, but we expect adjusting our algorithms to generate fully FRBR-compliant data, once such a data structure is defined, will not be difficult.

4. Automatically generated cataloging data in our production Variations system for all digitized audio and score page images currently delivered by the system, some 14,000 Containers (similar to the FRBR Manifestation). This will extend the Variations system search capability far beyond the current scope of less than 900 manually-cataloged Containers.

5. User studies comparing searching for musical materials in the Work-based Variations metadata model to MARC-based OPACs. The most recent user testing of the effectiveness of searching Work-based data we have performed was as part of the Variations2 project[19]. In the Spring of 2008, we will perform a new set of user studies aimed at helping us better understand how a Work-based system can improve the discovery of music materials.

Project Goals

The goals of this proposed project fall into two overarching themes: providing to the library community a concrete demonstration of how the FRBR conceptual model might work in practice, and advancing the Variations system to become more relevant and more sustainable in a constantly-changing technological environment. Our specific goals are:

1. To implement a FRBR-compliant data model within the Variations system;
2. To provide an openly-accessible web search interface to the FRBRized data in Variations, for community analysis;
3. To make supporting data, including data model documentation and FRBRized data, available to the community for analysis; and
4. To apply innovative, evidence-based interface design techniques to Variations cataloging and search interfaces to make the most of the FRBR-compliant data model.

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[15] FRBRoo Introduction, http://cidoc.ics.forth.gr/frbr_inro.html
[16] Expression of Core FRBR Concepts in RDF, http://vocab.org/frbr/core
[17] Music Ontology Specification, http://musicontology.com/
[18] See RDA Implementation Scenario 1 in Delsey, Tom. "RDA Database Implementation Scenarios." JSC/Editor/2, 14 January 2007, http://www.collectionscanada.gc.ca/jsc/docs/5editor2.pdf
[19] Variations2: IU Digital Music Library Version 2.1, Usability Test Report: Searching. December 22, 2003, http://variations2.indiana.edu/pdf/V2SearchUsabilityReport12-03.pdf

Project Activities

Our project goals will be met through a series of interconnected activities that fall in three categories.

Convert the Variations system to a FRBR-compliant data model.

1. Re-implement the data model underlying the production Variations discovery system to conform to the FRBR conceptual model.

2. Adjust the FRBRization algorithm developed as part of the Variations3 project to conform to the new, fully FRBRized data model.

3. FRBRize the approximately 80,000 MARC bibliographic records for audio recordings and 105,000 records for scores and parts in the IU William and Gayle Cook Music Library, plus all MARC authority records to which they refer, and load these records into the new Variations system. This represents a significant expansion of the current approach of the Variations system, which only includes metadata for digitized items, and provides search access only to items that have received cataloging attention from a staff member.

4. Manually enhance automatically FRBRized records, and add new records manually, to determine the costs of these activities.

Design and implement new user interfaces.

1. Assess user needs for the discovery interface through methods such as contextual inquiry and logs analysis to record user actions and information needs for the Variations discovery interface[20].

2. Design and implement a new, openly-accessible, web-based discovery system for Variations based on user study findings.

3. Assess user needs for the cataloging interface using contextual inquiry and focus groups or cognitive walkthroughs to determine methodology for user data entry and involve users in evaluation of design ideas.

4. Design and implement a new, web-based cataloging system for FRBRized Variations data, hiding the complexity of the metadata model to the degree both possible and desirable, and promoting efficient data entry.

Evaluation

1. After implementation, assess the new discovery interface by performing task-based user studies comparing discovery for music materials in the FRBRized Variations system with the previous version of Variations, traditional OPACs, and current music discovery software (e.g., the iTunes Music Store's genre browse, Magnatune[21], Ruckus[22], and All Music Guide[23]).

2. After implementation, assess the new cataloging interface by performing observational user studies such as contextual inquiry, field observation, and task-based studies to compare the effectiveness of the FRBRized Variations cataloging interface with both traditional OPAC cataloging interfaces and the cataloging interface of the previous version of Variations.

Expected Results

Concrete outcomes for community review are the cornerstone of the proposed project. We plan to deliver each of the following, to contribute in a significant way towards providing the information needed for replication of our work in other contexts. The specific results of this proposed project that will be shared include:

1. Details of our project FRBRization algorithm and an evaluation of its effectiveness;

2. Data dictionary and XML Schemas for the FRBR conceptual model, if we develop our own;

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[20] Notess, M. (2004). Applying contextual design to educational software development. In A.-M. Armstrong (Ed.), *Instructional design in the real world: a view from the trenches.* Hershey, PA: Idea Group Publishers.

[21] http://magnatune.com/

[22] http://www.ruckus.com/ruckus/home.do

[23] http://www.allmusic.com/

3. FRBRized data for approximately 80,000 MARC bibliographic records for audio recordings and 105,000 records for scores and parts in the IU William and Gayle Cook Music Library via OAI-PMH, SRU, and batch download.

4. An openly-accessible system for searching FRBRized music data for community testing and analysis.

5. Usability evaluations of end-user discovery and cataloging systems operating on FRBRized data.

6. Preliminary figures on the costs of creating FRBRized bibliographic data, including automatically generating records from MARC, human review and editing of automatically created records, and record creation from scratch using the new Variations cataloger interface.

7. Source code for the Variations FRBR-based discovery system.

Relationship to Other Projects

One barrier to large-scale, production implementations of the FRBR conceptual model is the lack of a formal data model that instantiates the conceptual model. The IFLA FRBR Review Group[24], as a volunteer organization, has not tackled this as a task, and in the absence of their involvement the library community has seemed to be reluctant to move forward on their own. At least two attempts at developing a concrete data model for FRBR have been performed, however. The first, known as FRBRoo, "…is a formal ontology intended to capture and represent the underlying semantics of bibliographic information and to facilitate the integration, mediation, and interchange of bibliographic and museum information."[25] FRBRoo represents an attempt to present FRBR in an object-oriented manner, and to harmonize FRBR concepts with those of the CICOC Conceptual Reference Model for cultural heritage documentation, an ISO standard[26]. As such, it adds additional complexity to the FRBR model, which is already criticized for its relative complexity to existing bibliographic models, and is not yet presented in such a way that a system can be easily designed around the model. Another ontological approach is displayed in the Music Ontology[27], developed by Music Technology researchers at Queen Mary, University of London. The Music Ontology came to FRBR late in its development, having begun focusing at the beginning in iTunes style on "artists" and "albums" rather than "works" and "performances." The other primary alternative, FRBR in RDF[28], was developed by Library and Information Science researchers, and, after an initial flurry of activity seems to be relatively dormant since. Both the ontological and RDF-based approaches represent significant deviations away from the technologies in use in most production library technology environments. It is yet to be seen whether a true FRBR data model would need to make use of some of these newer technologies, or if it would be possible to accomplish the same goals within existing environments. The Variations team will, as part of our currently-funded Variations3 project, conduct an evaluation of each of these alternatives against our project needs.

IMLS has funded a National Leadership Grant in the Research and Demonstration category to Kent State University, which proposed to examine current FRBR implementations, and design and test a new prototype FRBR implementation, from October 2006 - September 2009[29]. At the time of this writing, few results from this project are publicly available. What has been distributed shows some promise in informing the work of our proposed project, and the Variations team believes our proposed work will be the next step in putting into practice the theoretical lessons learned as a result of this and more theoretical FRBR research, such as that from the University of Illinois at Urbana-Champaign's Allen Renear[30].

Several FRBR or FRBR-like systems have been made available since the FRBR report was released, although most operate in a test or research environment. The biggest and most stable of these perhaps is AustLit: the Australian

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[24] IFLA FRBR Review Group, http://www.ifla.org/VII/s13/wgfrbr/
[25] FRBRoo Introduction, http://cidoc.ics.forth.gr/frbr_inro.html
[26] CIDOC CRM Home Page, http://cidoc.ics.forth.gr/index.html
[27] Music Ontology Specification, http://musicontology.com/
[28] Expression of Core FRBR Concepts in RDF, http://vocab.org/frbr/core
[29] FRBR-Based Systems to Effectively Support User Tasks and Facilitate Information Seeking, http://frbr.slis.kent.edu/
[30] See, for example, Renear, Allen H., Yunseon Choi, Jin Ha Lee, Sara Schmidt. (2006). "Axiomatizing FRBR: An Exercise in the Formal Ontology of Cultural Objects." in Digital Humanities 2006 Proceedings. Paris.

Literature Gateway, a collaborative endeavor of various Australian universities, operates on a FRBRized data model. A follow-on project, MusicAustralia, was evaluated for FRBRization, but this work was ultimately rejected due to the mismatch between the MARC records the project was to use as the data source and FRBR expectations.[31] The AustLit project has presented significant technical detail on their implementation on their project Web site, which could provide information to our proposed project about successful technologies to support a FRBR model. The most prominent FRBR-like implementation is likely OCLC's Worldcat.org[32], which provides Work-level clustering of search results. Worldcat.org provides a model for FRBRized results displays, but OCLC has yet to release concrete information on the data model underlying the system. All indications are that the system is not fully FRBR-compliant, however, not attempting to identify FRBR Expressions.[33] In addition, we expect developing next-generation catalog systems, such as the University of Rochester's eXtensible Catalog (XC), that are planning for "FRBR-like functionality and navigation,[34]" to be able to make use of the work products from this project.

Evaluation Plan

Evaluation of the work of this project will be heavily based in user studies, which will be divided into two segments: a Design Phase and an Assessment Phase. During the Design Phase (before development work begins), user needs will be assessed for both the discovery interface and the cataloging interface. Users will be observed using the current Variations discovery interface and interviewed to determine the actions they take and their impressions of what they need from such a tool. Logs analysis will also be performed to ascertain searching and browsing techniques and search terms used. Assessment of user needs for the cataloging interface will also involve observations and interviews with users of the current Variations cataloging tool. Focus groups or cognitive walkthroughs will be administered to evaluate design ideas with users.

After implementation of the new discovery interface and the new cataloging interface, the Assessment Phase will begin. To assess the effectiveness of the new discovery interface, task-based user studies will compare the new FRBRized Variations system against the previous version of Variations, traditional OPACs, and other music discovery software, such as the iTunes Music Store's genre browse, Magnatune, Ruckus, and All Music Guide. The new cataloging interface will be evaluated by observing users without any observer interference, interviewing users as they perform everyday tasks, and comparing similar tasks done on the new cataloging interface against the previous version of Variations and traditional OPAC cataloging interfaces.

In addition, we will perform assessments on the effectiveness of the project's FRBRization algorithm, determining what FRBR data cannot be automatically generated from MARC/AACR2 data. This evaluation will be essential to the library community as it investigates the balance between cost and benefit of moving library catalogs to FRBRized models. This and evaluation of new interfaces could benefit from outcome-based evaluation methods, by assessing whether users over time choose the new discovery system over the traditional OPAC, the degree to which the music library continues to use the Variations cataloging interface after the conclusion of this grant-funded project, and whether the library community as a whole moves towards FRBR implementation based on the findings of this project.

4. Project Resources

The project will be managed by the Indiana University Digital Library Program, with additional participation from staff in IU's Cook Music Library. The Digital Library Program is a partnership between the IU Libraries and University Information Technology Services, and is able to leverage the resources of both of these organizations to support the work of this project. The Digital Library Program has a long history of successful grant projects,

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[31] Ayres, Marie-Louise. Case studies in implementing FRBR: AustLit and MusicAustralia. In: *Evolution or Revolution? The impact of FRBR:* Melbourne, Convention Centre, 2nd February 2004, http://www.nla.gov.au/is/stndrds/grps/acoc/ayres2004.doc.

[32] http://worldcat.org/

[33] See, for example, Hickey, Thomas B. et al. "Experiments with the IFLA Functional Requirements for Bibliographic Records (FRBR)." *D-Lib Magazine* 8, no. 9 (September 2002), http://www.dlib.org/dlib/september02/hickey/09hickey.html.

[34] Lindahl, David, et. al. "University of Rochester eXtensible Catalog Phase 1 Final Report." September 14, 2007, http://docushare.lib.rochester.edu/docushare/dsweb/Get/Document-27534

including the past IMLS National Leadership Grant-supported Hoagy Carmichael Collection, Charles W. Cushman Photograph Collection, and IN Harmony: Sheet Music from Indiana digitization projects, and the 2005-2008 IMLS National Leadership Grant-funded Variations3 project.

Personnel

Existing Indiana University staff, many of whom have played key roles in earlier Variations projects, will contribute as cost share their considerable expertise to the proposed project:

Jenn Riley, Metadata Librarian for the IU Digital Library Program, will serve as Project Director, with responsibility for overall project management, administration of the project budget, alignment of this work with other FRBR-related work being performed in the library community, and coordination of the dissemination of project outcomes. She will also oversee metadata-related project activities, including the implementation of the FRBRization algorithm, and supervise the student employee focusing on metadata issues. Jenn has led metadata investigations for the Variations3 project and in the final phases of Variations2, including the work analyzing the application of FRBR to the Variations system. She has worked in the IU Digital Library Program since 2000, and in this capacity has served on project teams for several previous IMLS-funded projects. In addition to metadata expertise, Jenn has subject expertise in music, holding a B.M. and M.A. in music in addition to an M.L.S.

Jon Dunn, Associate Director for Technology in the IU Digital Library Program, will direct system development activities for this project and help to coordinate the project's activities with other ongoing development work on the Variations digital music library system. He has worked with digital music libraries at IU since 1994, first in the Music Library, and since 1997, in the Digital Library Program. He has served as Executive Investigator/Project Manager for the NSF-funded Variations2 digital music library research project, as Project Director for the IMLS-funded Variations3 digital music library and learning system development project, as Project Manager for the IU portion of the IMLS-funded Digital Audio Archives Project led by Johns Hopkins University, and as Technical Manager for the IMLS-funded IN Harmony sheet music digitization project.

Mark Notess, Development Manager in the IU Digital Library Program, will manage software development for this project, coordinating the development of formal specifications for the data model and interface changes to the existing Variations system, and supervising development staff hired with grant funds. In addition to serving as the Development Manager for the IMLS-funded Variations3 project, he served as Development Manager for the NSF-funded *Variations2* project at IU for two years, and prior to that worked in development management and usability roles at Hewlett-Packard, Agilent Technologies, and UNext, an online education company.

Phil Ponella, Director of the IU Cook Music Library, will serve as a liaison to IU Jacobs School of Music faculty to assist project staff with gathering requirements for and testing of the new Variations end-user search interface, and serve as the primary contact with the music library community for ensuring the system meets needs of users beyond Indiana University and publicizing the project's accomplishments. Prior to his arrival at IU in August 2004, he led Academic Technology Services at the University of Rochester. There he led the units who assisted faculty and students with the integration of new technologies into teaching and learning. He led programs in the area of intellectual property and copyright as part of the first implementation of Napster2.0 at a private university, and taught classes in the Eastman School of Music's Institute for Music Leadership.

Michelle Dalmau, Digital Projects and Usability Librarian in the IU Digital Library Program, will coordinate the visual and functional design of the new Variations cataloger and end-user interfaces, participate in definition of formal requirements for project developers to implement, and oversee user testing to evaluate the effectiveness of the new interfaces. Michelle brings to the project significant experience in designing interfaces to maximize the interaction between the user and the underlying system data model. Since 2002, Michelle has led a wide range of user studies for the IU Digital Library Program including studies that investigate user interactions with image, text and sheet music resources. Michelle holds a Master of Information Science with a focus on human computer interaction, information architecture and information retrieval and a Master of Library Science with a focus on digital libraries, information representation and metadata.

Julie Hardesty, Usability and Interface Specialist in the IU Digital Library Program, will perform the bulk of the design and user testing for the new Variations cataloger and end-user interfaces, and will supervise the student employee focusing on usability and design issues. She will work with project development staff to implement the new interface designs, and recruit faculty and students from the Jacobs School of Music to perform user testing on these designs that will provide real-world feedback on the effectiveness of FRBR-based cataloging and discovery interfaces. Julie has previously worked on both Indiana University's online library catalog and the Bloomington campus library web site, coordinating user studies, development work, and implementation of each of these major systems. Julie holds an M.I.S with a focus on information retrieval in addition to an M.A. in Art History.

Brian Wheeler, System Administrator in the IU Digital Library Program, will configure and administer production and testing servers for the Variations application supporting project activities. **Ralph Papakhian**, Head, Technical Services in the IU Cook Music Library will contribute to this project his considerable expertise in the MARC format, current and past AACR2 rules for cataloging music materials, and subject analysis practice in music. He will be involved in refining FRBRization algorithms and assist with the redesign of the Variations cataloging interface to support the new FRBR-based metadata model. **Keith Cochran**, Associate Director/Music Collection Development Librarian in the IU Cook Music Library will coordinate informal involvement from Music Library staff in this project, including testing of the system by staff and publicizing the project, and assist with planning and executing usability tests on the redesigned end-user and cataloging interfaces. **Spencer Anspach**, Library Systems Analyst/Programmer in the Library Information Technology department in the IU Libraries will serve on the project team in Year 1, identifying and extracting MARC records from IU's SirsiDynix ILS for FRBRization and loading into the Variations testbed system.

Budget

The bulk of Indiana University's cost share to this project comes from the personnel listed above performing planning and management activities. In addition, Indiana University will fund the purchase of workstations for grant-funded project staff and student employees.

IMLS funds are requested to support temporary staff whose responsibilities will be solely for the proposed project. These include two programmer/analysts, each for a period of two years, to perform the system design and development work required to FRBRize the bibliographic and authority records representing the IU Cook Music Library's collection, perform the necessary changes to the Variations system's data model to operate on the FRBRized records, and implement the proposed new cataloger and end-user discovery interfaces; and two student employees with specialized skills. One student will assist with planning and implementation of user studies on the cataloger and end-user discovery interfaces, and the other will focus on metadata issues such as the FRBRization algorithm and optimum methods of indexing FRBRized records for discovery.

We are also requesting IMLS funds for travel to disseminate project results, with the required $2000 per year for IMLS-designated travel, plus additional travel to appropriate conferences in each project year. Additional details in all budget areas are available in the attached budget narrative.

5. Dissemination

Dissemination of the results of our project activities will be a key factor in the success of this project. Its very nature suggests that dissemination of our findings must be one of our highest project priorities—a primary purpose of IMLS National Leadership Grants projects in the Demonstration category is to "produce a replicable model usable by other institutions for improving practice," and the Library of Congress Working Group on the Future of Bibliographic Control report that calls for more practical and transparent testing of the FRBR conceptual model serves as a significant driving force behind this project. We also expect that community feedback will inform our work agenda in later phases of the project.

Therefore, we plan to actively make available to the library and music communities both our primary and secondary work products from this project. The primary work products would include an openly-accessible search system demonstrating the utility of FRBRized data, the full set of FRBRized records, source code for the Variations FRBR-

based discovery system, the data dictionary and technical schemas (likely either an XML or RDF Schema) that define our FRBR data model if the project cannot re-use one developed elsewhere, and a human-readable description of the algorithm we use to convert MARC bibliographic and authority records into our FRBRized data model. Secondary, evaluative information that we would share could include reports on the effectiveness of our FRBRization algorithms, usability analysis of a FRBRized cataloging interface, and comparative studies of the FRBRized Variations discovery interface and more traditional OPACs. We also plan to make available cost figures associated with the creation of FRBRized records, including automatically generating records from MARC, human review and editing of automatically created records, and record creation from scratch using the new Variations cataloger interface.

In order to reach the wide range of parties that we believe will be interested in our work, we will use a variety of methods for disseminating project information. A project web site will be launched shortly after the project begins, which will make available our full proposal narrative and an easily-scannable list of planned project activities and outcomes. The primary and secondary work products discussed above will be posted to this site and to a project news feed as they are completed; ongoing engagement with the community will be our goal, rather than to simply release documents after the project is complete. We will also make openly available all project reports that we complete for IMLS. In addition, we will post to a variety of relevant email lists announcing major project milestones as they are reached.

The Variations projects have been historically well-represented in more formal dissemination mechanisms as well, such as conference presentations and journal articles,[35] and we plan to continue this practice with the proposed project. IMLS funds will support travel for members of the project team to relevant conferences to both informally discuss and to formally present our work. Conferences at which our work might be of interest include the Digital Library Federation Forum, the American Library Association (especially sessions sponsored by the Association for Library Collections & Technical Services and the Library and Information Technology Association), the Music Library Association, the International Conference on Music Information Retrieval (ISMIR), the ACM/IEEE Joint Conference on Digital Libraries, the Code4Lib conference, and the American Society for Information Science and Technology annual conference. More formal papers describing our activities and findings will be submitted for consideration in journals such as *Cataloging and Classification Quarterly*, *Library Resources & Technical Services*, *Journal of Library Metadata*, *Code4Lib Journal*, and the *Journal of the American Society for Information Science and Technology*. In addition, we plan to deposit appropriate versions of project papers, presentations, and reports in Indiana University's institutional repository, IUScholarWorks[36], and in LIS open-access repositories such as E-LIS[37] and dLIST[38].

6. Sustainability

Indiana University has made a commitment to providing ongoing baseline support for digital library services through its Digital Library Program, as one of ten major priorities in the University's Information Technology Strategic Plan. This commitment includes support from University Information Technology Services and the IU Libraries for equipment, software and personnel to sustain digital library collections and systems over the long term. This support has allowed the output of past IMLS-supported projects, including the Hoagy Carmichael Collection and Charles W. Cushman Photograph Collection, to remain available and accessible since their creation, and has supported the continued evolution of the Variations system over the past twelve years.

Through this ongoing IU Digital Library Program support, we intend to make the systems and data generated by this project available on the Internet for as long as they are perceived useful by the community. In addition, the publication and dissemination of project results through journal publication and open-access repository deposit noted above will serve to help disseminate within the community and sustain the results learned from this project.

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[35] A list of papers and presentations from the original Variations project is available at http://www.dlib.indiana.edu/variations/; from Variations2 at http://variations2.indiana.edu/papers.html; and from Variations3 at http://www.dlib.indiana.edu/projects/variations3/presentations.html.

[36] http://scholarworks.iu.edu/

[37] http://eprints.rclis.org/

[38] http://dlist.sir.arizona.edu/