Identifying the Serial Work As a Bibliographic Entity

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A solid theoretical foundation has been built over the years exploring the bibliographic work and developing cataloging rules and practices to describe the work in the traditional catalog. With the increasing prevalence of multiple manifestations of serial titles, as well as tools that automate discovery and retrieval, bibliographic control of serials at a higher level of abstraction is more necessary than ever before. At the same time, models such as the International Federation of Library Associations and Institutions' Functional Requirements for Bibliographic Records offer new opportunities to control all bibliographic entities at this higher level and build more useful catalog displays. The bibliographic mechanisms that control the work for monographs—author, title, and uniform title—are weak identifiers for serials. New identifiers being adopted by the content industry are built on models and practices that are fundamentally different from those underlying the new bibliographic models. What is needed is a work identifier for serials that is both congruent with the new models and can enable us to meet the objective of providing work-level access to all resources in our catalogs.

> *Using the word "work" ambiguously . . . is bound to entail rather unpleasant practical consequences.*
>
> —Á. Domanovszky, *Functions and Objects of Author and Title Cataloguing: A Contribution to Cataloguing Theory*

Ever since Cutter's *Rules for a Printed Dictionary Catalog* was published in 1876, identifying the work has been a key objective of the library catalog.[1] A half-century ago, Lubetzky, building on Cutter and Anthony Panizzi, laid out the importance of the work in his second objective (the first being to facilitate the location of a particular edition of a work): "to relate and display together the editions which a library has of a given work and the works which it has of a given author."[2] Online catalogs, like card catalogs before them, have struggled with achieving the right balance between the finding and the collocating objectives, often at the expense of the latter. A solid theoretical foundation has been built over the years exploring the meaning of "work" and developing cataloging rules and practices to describe the work in the catalog. Theory and practice have been built almost exclusively around the monographic work; much less attention has been paid to the development of a conception of a serial work. We are now faced with a bibliographic universe in which such a concept is needed.

Serials (a term used throughout this article for simplicity) have always been complex bibliographic objects, "characterised by conceptual unity despite and over physical/temporal fragmentation."[3] Tillett outlined seven bibliographic relationships: equivalence, derivative, descriptive, whole-part, accompanying, sequential, and shared characteristic.[4] Serials exhibit two of these: derivative (in possessing multiple formats) and sequential (in changing over time). With the

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proliferation of electronic journals and their derivatives, these relationships become more complex. Serials are collected by libraries in a variety of versions, or editions, through which users must sort, knowing that each version is not similar enough in content or other attributes to be equally likely to meet their needs. The ubiquity of Web electronic journal (e-journal) lists, powered by databases separate from the integrated library system, makes clear that we have not yet arrived at the optimal solution for either bibliographic control or display of these materials. Serials are an increasingly important part of our library collections; we can no longer afford to allow them to be a second-class citizen bibliographically. Following Lubetzky's second principle, we have a responsibility to communicate to users all editions of a work, the full range of library holdings, and other information the user may need to identify and obtain the desired item. Gaining control over an abstract serial work is key to achieving that objective.

The mechanisms that control the work for monographs—the main entry heading and uniform title—are weak identifiers for serials. Nevertheless, the serial work is, in practice, closely linked to title. The equation of title with work in current cataloging practice has led to the creation of new works where neither the cataloger nor, more importantly, the library user, would see a new work. For a variety of reasons, controlling the serial work has not been a priority, and changes in cataloging codes over time have weakened that control. Thus, what we are facing now is a known problem with new—and serious—negative consequences.

A fresh approach to implementing the abstract work layer in bibliographic control is offered by the much-discussed model to guide catalog development, the International Federation of Library Associations and Institutions' (IFLA) *Functional Requirements for Bibliographic Records* (FRBR).[5] One opportunity presented by the FRBR reference model is a truly abstract conception of the work. FRBR itself, however, borrows familiar bibliographic concepts and structures, and views the problems from a familiar perspective. This, in part, reflects what is inevitably an evolutionary process of change. However, even were FRBR a more radical proposal or our scope for change broader, our approach to bibliographic description would continue to assert the importance of semantic control over data elements and of recording relationships between works, items, and other works. What is exciting about such entity-relationship data models as FRBR is the potential to apply more sophisticated tools to improve our ability to realize these longstanding objectives.

We find ourselves working now in the dynamic space at the intersection of bibliographic control and networked documents. Our collections extend beyond the library's walls, not only because most of our digital collections are remotely housed, but also conceptually, as people (including library users) no longer see libraries as having a monopoly over knowledge and information resources. Thus, the problems faced by architects of the Web are not divorced from practical problems in libraries. Documents do not need to be *described* to be referenced in a networked world; they must be *identified*. An inherently descriptive element, such as title, cannot meet the requirements of a network identifier. The new bibliographic identifiers, such as the Digital Object Identifier (DOI) and the proposed International Standard Text Code (ISTC), seek to fill the need "to automate discovery to delivery chains," but they are shaped by the business needs of those who publish and sell content.[6] As these new identifiers are being deployed rapidly, librarians must look critically at the question of whether they are compatible with our objectives for bibliographic control of works.

As experiments in converting existing MARC-based catalogs into FRBRized records have shown, libraries have the opportunity to test new bibliographic models within the constraints of existing systems.[7] A concept such as a serial work identifier could be explored within local electronic resource management (ERM) systems, for example, providing immediate benefits to library users. As the excitement surrounding FRBR has shown, new conceptual models can help us revisit classic questions of librarianship and increase our appreciation of the importance of adhering to well-understood principles as new technologies rapidly take hold.

Serial Work

The Bibliographic Work

The concept of the bibliographic work has been examined by many great minds in our profession since Cutter's rules first recognized the literary unit. What is meant by work is far from straightforward, Lubetzky explains, "because the material *book* embodies and represents the intellectual *work*, the two have come to be confused, and the terms are synonymously used not only by the layman but also by the cataloger himself."[8] This ambiguity has not been particularly problematic thus far because most works, in particular monographic works, are represented by only one physical item; thus the work and item can both be referenced by the same main entry.

At least three distinct points of view on the work were articulated by Wilson. He wrote, "The everyday notion of a work is correlated with that of an author."[9] A common notion of work would identify multiple editions of a novel as a work but not an anthology of works by multiple authors, for example. From the textual scholar's perspective, a work is a combination of a conceptual abstraction (such as ideational content) and a specific semantic representation of that abstraction (such as linguistic content). Finally, a librarian's conception of the work is both broader than the com-

mon and scholarly conceptions, in that we would consider the anthology also to be a work, and narrower, in that we do not analyze all works contained within such aggregations.

Bibliographic scholarship on the work reflects the tension between these three perspectives (author, textual scholar, librarian) in large part because of bibliographic theorists' adoption of the textual scholar perspective: "A *work,* at a basic level, is a deliberately created knowledge-record representing a coordinated set of ideas (i.e., ideational content) that is conveyed through text. . . . A document may contain one or more works."[10] While this conception is easily applied to monographic works, when extended to serials it implies that each article is a work and each issue is a document. Svenonius might characterize that issue as a "superwork."[11] Domanovszky proposed a conception of a literary unit that comprised bibliographic items linked by relationships that "preserve the identity" of the original.[12] While Domanovszky viewed a wide range of transformations (such as revisions, editions, translations) preserving work identity, Wilson pointed out that using the concept of identity in such a broad way is problematic because it diverges too greatly from the scholarly notion of textual identity, which emphasizes specific linguistic content. Wilson helps lead us away from the restriction of the textual scholar's view of a work by concluding that the broader concept of literary unit can be adopted as a conception of a work without reliance on identity.[13]

The FRBR model also reflects the tension between the three conceptions of work. The tension can be seen both in the FRBR text itself and in commentaries on the model. Even those who interpret the FRBR *work/expression* as an abstraction with relatively stricter identity requirements acknowledge the need for the work also to serve purposes of bibliographic control. The proposed collocating device, defined as a higher level of abstraction over work, has variously been termed "superwork," "superwork record set," "super records," or "package content."[14] At that level, this collocating device would bring together the movie version of a textual work, derivations, and so on. Whether this level is already represented by the existing work or is conceptually distinct, there is a practical need in bibliographic control for a level of abstraction that brings together related items that do not exhibit textual identity. Hagler reminds us that the work need not be supported by an unassailable theoretical underpinning to be useful for bibliographic control.[15] This perspective is useful to keep in mind as we look at the problems of identifying the serial work.

Need for a Higher Level of Abstraction for Serials

Before a higher level of abstraction for serials is conceptualized, the practical need should be assessed. Library users looking for a given article do not care about the entire title history of the journal in which the article is contained. On the other hand, we can recognize today's serials in Lubetzky's characterization of a work: "a given work may be represented in a library in different forms or editions, under different names of the author or under different titles."[16] The reason for the second objective is that users are better served when they find together the various editions of the work so that they can select the most suitable edition for their own purposes. In the world of paper journals, version was a non-issue, except in the case of microforms, where, in fact, our multiple catalog records also confused users. Now, with libraries holding multiple electronic versions of journals (not all of which are equivalent in content or even have the same title), users have a need to see versions and holdings collocated. In this environment one does not want only holdings associated with manifestation-level catalog records; all holdings should be able to be collocated and presented at the work/expression level. Another reflection of this same problem is that as we build reference-linking solutions around either title or International Standard Serial Number (ISSN), we are creating links at the wrong level. The link should go to the work/expression and not to the multiple individual manifestations.

The work conception also could help with new title change challenges associated with electronic resources. Newspaper and journal Web sites can now exhibit the previously impossible behavior of changing title retroactively; for example, as Jones has pointed out, "If a publisher decides that Title B is, for whatever reason, a better title for such-and-such a serial than Title A, then it will be the better title for the whole *work,* not just for the parts issued after the decision has been reached."[17] Yee looked at this problem from the user's perspective: "now e-serials are continuously updated databases . . . extend across title changes. . . . Users surely consider both the database and the journal they seek (under any title it has held) to be different versions of the same work."[18] A complete picture of the serial work over time also would allow the cataloger (and catalog) to display the serial's complete bibliographic history and not just the pieces that happen to be owned by the library. Other uses are also imaginable. For instance, collection managers could take a bird's eye view of the evolution of disciplines across time. Unfortunately, catalogers and automated catalog systems currently lack the appropriate tools to manage these versions in a hierarchical structure.

The Serial Work in Practice

Uniform Titles

From the perspective of bibliographic control, a collected works would itself be considered a work. Analogously, an article in an issue of a journal is clearly a work, and the issue could possibly be considered an anthology work, but is the journal itself a work? Here a library user's common sense answer would be "Yes, *Atlantic* and *Atlantic Monthly* both refer to a

single work over time." Yet, from the textual scholar's perspective, since each issue of a journal is unique both ideationally and semantically, referring to a whole journal as a work makes no sense. As we turn to the bibliographic conception of the serial work, we find that the question has not been well explored in the cataloging literature. Lubetzky believed that there is neither a serial work nor the need for such a concept because "a serial does not have the organic unity of a monographic work, it is rather a source of various works, and both the one who cites and the one who looks for a serial is almost always concerned with the part identified by a particular title, not the history of the whole serial."[19] Delsey highlighted the conceptual difficulty of identifying the work for works of shared and mixed responsibility within the framework of AACR2, yet contended that the serial work is encompassed in the FRBR aggregate work.[20] Le Boeuf similarly believed that continuing resources, including serials, are regarded by FRBR as works, despite the considerable conceptual and practical challenges in applying the model.[21] So while applying the theory of a work to serials is difficult because serials as a class of materials must be defined primarily for bibliographic control purposes, the problem remains that library users' sense of a serial work diverges significantly from the way it is currently implemented in library systems.

The work is embodied in our cataloging code in the form of the name/title main entry heading and implemented through uniform title and authority records. The crux of the serial work problem is that neither name nor title are reliable identifiers of a serial work. In the past, this problem was ameliorated in our catalogs by two work-like devices: earliest or latest entry cataloging, which grouped all titles resulting from title changes together on a single record, and author main entry for serials that were the product of a corporate body and therefore susceptible to both title changes and having non-unique titles. The adoption with AACR2 of successive entry cataloging and title main entry for most serials undermined this work-like collocation and strengthened the association between title and work. Lubetzky acknowledged the cost of taking this practical course:

> The idea of entry under successive titles . . . may seem to be in violation of the second objective. A serial, however, is a constantly evolving thing, and there is here a practical problem. Often the cataloger can establish the complete history of a continuing serial only with time and trouble, and each change of title after that would mean recataloging.[22]

With the move to title main entry for most serials, authority control of the serial main entry disappeared and new problems arose that stem from the weakness of title as a work identifier.

Uniform titles are defined in AACR2 as "the means for bringing together all the catalogue entries for a work" (rule 25.1). Even leaving serials out of the picture, the role of the uniform title in work identification is not clear-cut. From the perspective of a developer of online catalog software, uniform titles suffer one major limitation as a device for controlling works: they are optional. In other words, in most cases (where the work only has one manifestation in the *local* catalog), no authority record is created, leaving the bibliographic record to serve the dual purpose of representing the *work* and *manifestation* in FRBR terms. FRBRization studies have quantified this problem and led some to suggest that authority records be created for all works.[23]

Of greater interest in the serials context is the fact that the uniform title serves an entirely different function for serials, one that does not assist with work identification. In 1981, the Library of Congress released a Rule Interpretation (codified in AACR2 in 1993) to address the problem of non-unique titles that had arisen as a result of AACR2 ending the practice of corporate main entry. The solution was to differentiate titles by using the uniform title to record a unique serial identifier, which would be created by adding a qualifier (under guidelines that have shifted over the years) to a non-unique title proper. Of course, collocation and differentiation are different, in fact contrary, objectives and, as Bloss pointed out, "calling unique identifiers for serials 'uniform titles' is a misnomer."[24] Thus, even if uniform titles were not optional but required, as has been proposed, they would not help with serial work identification.

The use of uniform title for two distinct purposes is more than a semantic problem. It is at best cumbersome and at worst impossible to program a catalog system that uses the same element (embodied in the same database record and designated MARC field) to serve two distinct purposes. A more serious consequence of the distinguishing use of uniform titles from the software developer's perspective is that serial authority records do not contain information about relationships between title variants; that information is in the bibliographic record. Systems developers (and therefore our catalogs) find it virtually impossible to properly represent the catalog's authority structure by taking advantage of the rich network of relationships coded in serial bibliographic records. One also may ask, what is the purpose of constructing a serial uniform title? The paper dictionary catalog needed one to serve as a main entry heading; in an automated system, information taken from the rest of the bibliographic record is available for the system to draw upon to distinguish between identical titles in an index display. Carpenter took this reasoning a step further in pointing out not only that "the establishment of a single 'official' form of name is meaningless in an online catalog," but that the uniform heading "mistake was canonized in the separation between the MARC authority and bibliographic formats," as a result "losing the

logical relationship" between the two.[25] As Bregzis noted, the ability to return a result set showing the form of name or title the user entered would be a conceptual return to Cutter's syndetic catalog.[26]

ISSN and Cataloging Practices

Because of the utility and widespread adoption of ISSNs, harmonization between cataloging practice and the rules for assigning ISSNs has been identified as a desirable goal. This also has helped to move the bibliographic conception of the serial work closer toward equivalence with title. In order to support "hook to holdings" and other data interchange based on ISSN, the goal is that each bibliographic record would correspond to a single ISSN. However, substantial conceptual challenges to harmonization exist. For instance, while similar, the identification objective of the ISSN key title and the distinguishing objective of the uniform title are different.[27] Integrating entry, while congenial to a more work-based display, is also a challenge to harmonization because the ISSN relies on successive entry. Although the ISSN explicitly does not identify a serial work, but is instead a precise identification of each form of the title (and this is well understood), harmonization of rules for title changes is a challenge when seeking to meet the objectives of both publisher and library constituencies. Another practical harmonization challenge is the ISSN policy that "when a publication is published in different media, with the same title or not, different ISSN and key titles shall be assigned."[28] Harmonization may well be achievable in practice, but it will come at the price of further compromising the already weak work-level control of serials in our catalogs.

New Models Bring New Opportunities

The MARC/AACR model has two entities, work and item, whose attributes and relationships to other works and items are described in AACR2 and coded in MARC bibliographic and authority records. The resulting records are themselves entities within the catalog. They are records that are related through filing relationships constructed by catalog developers using the available MARC data, cataloging rules, and proprietary programming. Thus, the linear catalog relies upon a mixed explicit and implicit authority structure, which is weak for serials, to meet the collocation objective.

The late 1970s witnessed a burst of creativity in reconceptualization of the catalog in light of automation. In 1977, Gorman proposed a model he termed the "developed record," in which there were three entities: the name package, the work package, and the subject package. The cataloger's work would focus on creating links between the packages. He later expanded on this model by describing HYPERMARC, a more relational successor to MARC, which would be "a complex structure expressive of all the bibliographic relationships between works and objects."[29] Tillett characterized an aspect of this model as an "access control record" and pointed out that Gorman's proposed record structure "would fit very well in today's FRBR conceptual model of the bibliographic universe."[30] Cataloging theorists, in struggling to define the work/item boundary, also have pointed out the need for a deeper hierarchy to support better catalog displays.[31] The new entity-relationship (or object-oriented) models, such as FRBR, represent a shift from the current commingling of access objectives, data structures, and rules, as manifested in MARC and AACR2, to a clearer focus on bibliographic description based on well-defined entity attributes and explicit relationships between entities.

Serials and the Functional Requirements for Bibliographic Records (FRBR)

The FRBR report proposes a new approach to bibliographic description, one that explicitly builds on existing theory about the work and modern data modeling techniques.[32] While FRBR may not be as radical a change as some say is needed, it does stand as a clear conceptual counterpoint to the current MARC/AACR model for the development of library catalogs. FRBR is a user-centered model, explicitly relating its organization of entities and attributes to the user tasks identified by the 1998 IFLA modification to the Paris Principles (find, identify, select, and obtain).[33] It serves as a "reaffirmation of the assistance library catalogs must provide to users" independent of specific catalog or data exchange technologies.[34] FRBR prompts us to refocus our attention on works and their manifestations rather than simply the manifestations themselves.

The FRBR model is built around the centrality of relationships in bibliographic description. In creating separate, abstract, top-level bibliographic entities (work and expression) within a relational structure, FRBR shows that explicit relationships between conceptually distinct entities are the highest priority in bibliographic description. In positing this, FRBR addresses a principal weakness of current practice, which, as Tillett pointed out, is that "we lack principles for consistent, logical treatment of relationships."[35] Smiraglia's research demonstrated that 63 percent of derivative bibliographic relationships are not expressed by catalog records at all.[36] Much information about relationships between records is conveyed only through proximity in an alphabetic catalog display. The interpretation of the meaning of the proximity of records is left to the human catalog user and relies on a conceptual framework that may not be understood by that user. Where the relationships are explicit, such as "see" references or preceding and succeeding titles, they are actionable only in

the context of the catalog. In an entity-relationship model, multiple relationships between entities—not bibliographic records—can be explicitly coded. Because entity description is separate from the relationship between entities, the meaning of the relationship is not dependent on, or affected by, any given format for storing the data or rules for its display. As Bennett wrote, "FRBR's primary benefits extend from its hierarchical structure, permitting the placement of bibliographic information at its appropriate level of abstraction and facilitating its inheritance."[37] Note that these benefits only accrue if the layers (entities) and associated attributes (such as title, author) are conceptually distinct and unambiguously defined, thereby preserving the meaning and potential uses of relationships between them. Attributes at the appropriate level are associated with the highest possible entity and are inherited—not repeated—by lower level entities. See figure 1, which is an XML-like hierarchical representation of a work record. By implication, assigning attributes to the wrong entity undermines the integrity of that entity, and therefore the overall coherence of the model.

The question of whether or not a serial can be a work carries forward into FRBR. The authors of the FRBR report avoid addressing the issue directly, as do most commentators on the model who tend to focus on monographs and music. Nevertheless, the introduction to the FRBR report states, "The study endeavours to be comprehensive in terms of the variety of materials that are covered . . . [covering] all formats (books, sheets, discs, cassettes, cartridges, etc.)."[38] While the report contains no serial examples, one can infer that serials fall under FRBR's scope because they are referenced in the document in sections 5.3.1.1 and 5.3.2.1. Delsey, and Hirons and Graham, believe that the FRBR work is applicable to serials. Delsey wrote, "At a conceptual level, the entity defined as *work* in FRBR is clearly applicable to works issued serially. In the FRBR model, the serial *work* would be viewed as an *aggregate work*."[39] The aggregate work in FRBR, an interpretation of work, supports Wilson's conception of the literary unit—that is, the work as defined for purposes of bibliographic control. FRBR appears to implement Smiraglia's and others' conception of the work through its two abstract layers—work for ideational content, and expression for semantic. The FRBR document states that the expression level is equivalent to a specific linguistic representation: "Strictly speaking, any change in intellectual or artistic content constitutes a change in *expression*. Thus, if a text is revised or modified, the resulting *expression* is considered to be a new *expression,* no matter how minor the modification may be."[40] If semantic content is equivalent to a single linguistic representation of a work, questions arise about the abstract nature and role of the expression entity. One can appreciate librarians' confusion in how to apply such a concept in practice, across many material types.

work
id=1
status=continuing resource
    expression 1
    content=full text
    title=New York Times
    […]
    id=1.1
        manifestation 1
        format=paper
        […]
        id=1.1.1
        manifestation 2
        format=microfilm
        […]
        id=1.1.2
    expression 2
    content=selected articles
    title=New York Times
    […]
    id=1.2
        manifestation 1
        format=digital
        […]
        id=1.2.1
        manifestation 2
        title=New York Times Upfront
        format=digital
        […]
        id=1.2.2

Figure 1. Simplified representation of a serial work

Hirons and Graham take a somewhat different approach to the abstract layer for serials and place publication status (ongoing or not) at the FRBR work level. At the expression level, they place differences in content and mode of expression, although they highlight the problem of where to draw the line between different expressions of the work.[41] The American Library Association's Machine-Readable Bibliographic Information Committee (MARBI) has proposed an approach more congenial to the operationalization of the abstract layers: "the entities work and expression are often only discovered by a process of extrapolation based upon comparing similar manifestations."[42] If implemented using FRBR, the serial work would be a bibliographic control device designed to achieve specific objectives; namely, to assist the catalog user in identifying relevant relationships, holdings, and characteristics of serial editions. Although subjecting serials to the full weight of the theoretical overhead of the work is not needed, explicit clarification of how serials fit within the FRBR model is needed before this work can begin.

Bibliographic Families

The concept of the bibliographic family is related to that of the work and is well suited to serials. The bibliographic

family was formulated in Wilson's definition of the work as "a group or family of texts."[43] Smiraglia proposed a definition of bibliographic family based on Tillett's derivative relationship: a "network of related works . . . constitutes a bibliographic family—the accumulation of works that deliberately share ideational and semantic content, and that are derived from a progenitor work."[44] The ability of bibliographic families, which also could be seen as superworks, to trace sequential relationships would better support a key attribute of serials—change over time—which our current catalogs do poorly. The model would have to be modified or adopted only at the broad conceptual level, however. To abide by the precept of the bibliographic family—that it is a collocating device of works related to a progenitor—one would have to stretch the bibliographic family concept of work to include a journal. One also would want to de-emphasize relation to a progenitor work in favor of relationships between titles over time. The bibliographic family model also could help address the challenge of defining the boundary between works by blurring that boundary. Users who seek to find and obtain a specific edition of a given serial are not making use of work boundary information. If all bibliographic relationships between works, expressions, and manifestations were codified, a big net would be created, encompassing not only changes in author and title, and splits and mergers, but even changes in scope (for example, in links between related works). See figure 2 for an example of a bibliographic family representation of related works. Individual manifestations would point back to the nearest expression or work relation within the bibliographic family. Families would grow over time, but would probably still remain distinguishable. This approach is congenial to data modeling (although it does not necessarily map easily onto the FRBR model) and, with current Web technologies, could be presented to users through a variety of illuminating displays that represented the relationships. While catalogers usually cannot examine each issue of a journal to judge when changes merit creation of a new work, perhaps experience would prove that most work-level changes announced themselves through changes in title, author, numeration, or a combination of these. The shift of cataloger effort would be toward the explicit recording of the numerous relationships characteristic of serials, work that is not only practical but is in large part already being done.

As valuable as a modified bibliographic family model might be for serials, converting our existing bibliographic data into bibliographic families would not be a simple matter. A number of studies have been conducted to evaluate the feasibility of converting existing bibliographic records into bibliographic families.[45] These studies all explicitly excluded serials; moreover, their findings are not easily extensible to serials because bibliographic families are currently identified primarily through the use of main entry. For serials, families most likely would be created using standard numbers. In a study done to test the use of the linking entry fields (780, 785), where OCLC, LCCN, and ISSN numbers are recorded for serials, Alan found that approximately 70 percent of the title-change record sets could be linked if the approach took into account the presence of any one of the three standard record control numbers.[46] In addition, in our current systems, not only are the serial family relationships recorded by the cataloger hidden within bibliographic records, not all members of the family are present. Yee looked at this problem from the user perspective:

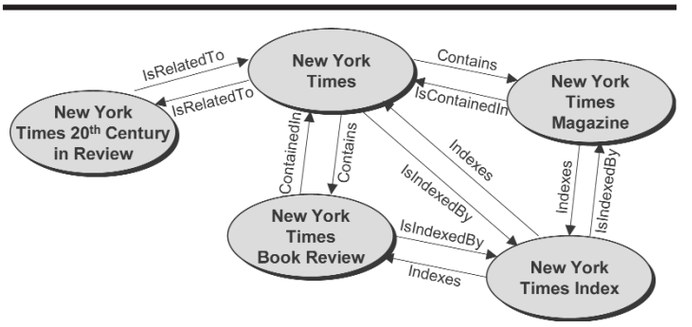

Figure 2. A bibliographic family of serial works

> The various related works that make up the history of a given serial can only be assembled by a user who happens to be in a library that holds issues entered under each title the serial has held. If there are any missing links, the run cannot be assembled.[47]

In a networked library that potentially offers a range of services to connect users with the desired full text, these practices send users into a needlessly constricted view of our library collections.

Identifiers

Title As an Identifier

Can a bibliographic entity, such as the FRBR work, be truly abstract if its description includes a literal (and changeable) attribute? Hagler noted that "titling straddles the venues of work and document" and asserts that the title can only exist at the manifestation level: "A natural-language title (title proper) can be counted upon to identify *only* the document bearing it."[48] While in archetypal cases (such as *Hamlet*) a creative work is known by a given title, there are many more examples, including most serials, where no such obvious linkage exists because no "progenitor work" exists in the

classic personal author sense. Yee has noted the problems with relying on serial uniform title to represent the work: "The title is a frail reed to bear the burden of displaying relationships between works in our catalog. . . . the title must be propped up with parenthetical additions completely invented by catalogers and difficult for users to predict."[49] She also proposed that we study changes in scope and content of serials independently of title changes.[50] If we accept that the serial can be an abstract entity at all, we see that title, author, both, or neither can change without a change in the underlying work as a user would perceive it. In a bibliographic world where the digital, mutable item is primary, and where the work is typically represented by multiple manifestations, the abstract work level is even more important. Inherently mutable attributes, such as serial title, cannot successfully fulfill the role of a work identifier. If we did not rely on title as an identifier, what would a work-level description look like? Jones echoed the image of the bibliographic family in proposing that at the work level there:

> would be no bibliographic description per se because there would be nothing physical to describe. Rather, a sort of extended abstract would describe the various relationships with other entities . . . beckoning the user down the various paths reflecting those relationships.[51]

But because the system must be able to follow that path, the only essential attribute of the work is an unambiguous, "dumb" number, work-level identifier.

Authority Record Identifiers

Substantial work has been done on the question of an authority record identifier, conceptually related to an identifier at the work level. The early work stemmed from the 1974 UNESCO and 1977 IFLA/UNESCO directives that "each bibliographic agency should maintain an authority control system for national names, personal and corporate, and uniform titles in accordance with international guidelines."[52] These efforts acknowledged the inevitable failure of any given language or culture's definition of a name to be satisfactory to all others. Tillett has been influential in making this argument: "When we equate a single form of name for the entity with the entity itself, we ignore the international perspective."[53] In the 1970s, an IFLA group led by Delsey proposed an International Standard Authority Number (later the International Standard Authority Data Number [ISADN]).[54] Implementation of such an initiative was judged to be cost prohibitive given the state of technology at the time and the associated administrative costs. IFLA, after publishing FRBR and recognizing that it did not address authority control, appointed a working group, Functional Requirements and Numbering of Authority Records (FRANAR). Patton, chair of the working group, put his finger on a key problem that had also emerged in the context of work on the ISADN: "Throughout these discussions, there remained the nagging question of 'what exactly were we attempting to number?'"[55] As a result, FRANAR is focusing on specifying functional requirements, much as FRBR did, rather than tackling linking mechanisms. The current IFLA Cataloging Section's Virtual International Authority File (VIAF) initiative builds on the long-standing idea of eliminating or de-emphasizing the authorized heading.[56] Recalling the access control record, the VIAF project would allow local customization ("my opac" based on browser cookie settings, for example) to identify the preferred language, script, and form of name for display.

Patton's question about what we are numbering bears repeating in the broader context. Any authority record identifier still will reflect the current model in which the abstract serial work is not well represented in the authority structure. It will also be tied to a bibliographic/authority structure that is only made manifest to users, and usable by systems, through online catalog software.

Identifiers in a Digital Environment

The usefulness of identifiers, which Schottlaender characterized as "a highly concentrated kind of descriptive metadata," is widely acknowledged.[57] In order to create intelligence in a system, an identifier linked both to functional metadata (such as bibliographic description) and formal relationships between structured entities (such as FRBR) is necessary. In 2001, Berners-Lee, the founder of the Web, set forth his vision of the "Semantic Web," a Web that would extend beyond links between pages to a Web where people issued queries that would retrieve semantically meaningful and contextualized information.[58] New technologies and protocols to advance the Semantic Web are rapidly being developed under the general leadership of the World Wide Web Consortium. The Semantic Web is based on machine-to-machine communication and, therefore, requires that actionable, persistent digital identifiers be associated with information objects or documents. Several such identifiers are in use or have been proposed to identify bibliographic works.

<in*d*ecs>-Based Models

<in*d*ecs> (Interoperability of Data in E-Commerce Systems) is a metadata framework for the exchange of bibliographic data to describe and manage intellectual property.[59] It is emerging as the dominant model for metadata and identifier systems used by publishers. It serves as the foundation for the EdItEUR ONIX data dictionary, the interna-

tional standard for representing and communicating serial and book industry product information, and is being carried forward in collaborative projects that bring together parties interested in intellectual property management.[60] Within this framework, the International DOI Foundation, which manages the DOI (Digital Object Identifier), is mapping its data elements to the <in*d*ecs> Data Dictionary.[61]

The <in*d*ecs> model is based on guiding principles, the first of which, "the principle of unique identification," recognizes the importance of the basic requirement of a universal resource name (URN): "every entity should be uniquely identified within an identified namespace."[62] (The implications of another key <in*d*ecs> principle, the "principle of functional granularity," will be discussed in more detail below.) Despite its primary purpose to manage intellectual property, <in*d*ecs> is not limited to administrative metadata supporting intellectual property transactions. It also recognizes the value and importance of descriptive metadata:

> <in*d*ecs> proposed that descriptions of content, transactions and descriptions of rights are all inextricably linked, and recognised that accurate descriptions of content are the core on which the rest is based.[63]

The <in*d*ecs> entities do not correspond to FRBR entities, however. <in*d*ecs> defines the work level, which it terms "abstraction," as "a creation which is a concept; an abstract creation whose existence and nature are inferred from one or more expressions or manifestations."[64] Although this recalls the FRBR work, Le Boeuf pointed out that the abstraction entity "actually corresponds to a subclass of Expression that might be labeled as Expression_in_notated_form."[65] Such an expression is hard to distinguish from the FRBR manifestation. He stated further, "This is an important difference to recognize, if we wish—and I think it is in our interest to do so—to keep the overall structure of our catalogues interoperable . . . in the perspective of the Semantic Web."[66] The benefits of extending interoperability between library and data suppliers' systems are indisputable, but <in*d*ecs> deserves more scrutiny before the library community embraces its model and assumptions about descriptive metadata.

DOI

The Digital Object Identifier (DOI) is an increasingly popular identifier that potentially could help with serial work identification. DOI grew out of publishers' need to manage their intellectual property, primarily journal articles, and to support persistent links to journal content. According to Norman Paskin, director of the International DOI Federation (IDF):

> A DOI persistently identifies an entity of relevance in an intellectual property transaction and associates the entity with relevant data and services. An entity can be identified at any arbitrary level of granularity.[67]

The DOI Federation, which administers the DOI, provides the full infrastructure to make the DOI an action able identifier.

Even though a DOI is typically assigned to what would be a FRBR manifestation-level document, the IDF has adopted the <in*d*ecs> principle of functional granularity ("it should be possible to identify an entity whenever it needs to be distinguished"): "a DOI can be assigned to any entity which is a Resource within the indecs context model."[68] The *DOI Handbook* explicitly includes abstractions (works) within DOI's scope:

> DOI can be assigned not only to manifestations of intellectual property (books, recordings, electronic files) but also to performances and to "abstractions"—the underlying concepts (often referred to as "works") that underlie all intellectual property.[69]

Paskin stated:

> The IDF's role in co-sponsoring, championing, and now implementing the <in*d*ecs> framework as a semantic tool for structured metadata [is] an essential step for treating content as information in Semantic-Web-like applications.[70]

There are a number of policy and practical issues for libraries to consider with DOI. Libraries can and have joined the International DOI Foundation, which is the requirement to be able to assign DOIs. The question remains, however, if publishers are assigning manifestation-level DOIs to objects, how can the abstract entities represented in those objects also be coded with work-level DOIs? The library community is not likely to have an interest in doing this at the article level, but conceivably will have an interest is doing so at the journal work level. In fact, since DOIs can be assigned at any level, CrossRef is encouraging publishers to assign one DOI to journal titles.[71] Paskin has written that "[in a] possible future evolution of the DOI system . . . a single DOI for the work could be resolved to multiple additional DOIs for versions of the work."[72] Publishers assigning work-level identifiers also raises the question about what they are really identifying. Without bibliographic control of the entities to which the identifiers are assigned, any so-called work-level DOIs that are created will remain tied to a title-based model that, if originating from publishers, is unlikely to correspond to current cataloging practice.

International Standard Text Code

The proposed International Standard Text Code (ISTC) is an identifier in development under the auspices of an International Organization for Standardization (ISO) working group.[73] A number of commentators on FRBR point to the ISTC as a possible solution to the work identifier problem.[74] The project is currently stalled over the business question of identifying an organization that is willing and able to serve as the registration authority, and the fate of this identifier is uncertain. ISTC was modeled after the successful International Standard Musical Work Code (ISWC) (although ISWCs do not identify a musical work in the FRBR sense because musical arrangements, adaptations of lyrics, and translations each receive their own ISWC). ISTC purports to identify a hybrid FRBR work/expression. It has been met with significant criticism—despite being ultimately endorsed—from the international library community over failing to adhere to the FRBR model.[75] Le Boeuf concluded that "'textual abstract entities' as defined in ISTC are considered as a sub-class of the FRBR 'Expression' entity."[76] The ISTC-required metadata, as the American National Standards Institute/National Information Standards Organization (ANSI/NISO) response to the ISTC proposal pointed out, draws from the work, expression, and manifestation levels.[77] This approach is a reflection of the business needs driving the creation of ISTC and its close association with the <in*d*ecs> model.

The Principle of Functional Granularity

DOI and ISTC reveal the underlying philosophy and motivations of the communities of interest that use (or hope to use) these identifiers in systems that exchange bibliographic data with associated expressions of intellectual property rights. These systems are not library systems, but administrative systems designed to meet the business needs of their stakeholders. Libraries' use of ISSN serves as a good example both of what can be gained by piggybacking on identifier systems designed around business processes (such as efficiencies in material acquisition) and what is sacrificed (such as principles of bibliographic control). Our experience with ISSN alone should alert us to the consequences of adopting identifiers that bring with them the baggage of both new descriptive metadata models and the interpretations and practices of their guiding organizations.

At the heart of the DOI and ISTC is adherence to the <in*d*ecs> so-called "principle of functional granularity," which states that "it should be possible to identify an entity whenever it needs to be distinguished."[78] In theory, this means that entities at all levels can be described and assigned an identifier and, by implication, that only the entities that needed to be described would be. In practice, a truly abstract work-level identifier rarely if ever would be assigned because it is not needed by the applications that use these identifiers. A more serious concern with the principle of functional granularity is that, while it responds to the immediate needs of the business community to manage objects with potentially complex associated intellectual property rights, it introduces ambiguity in entity definition and the boundaries between entities. Caplan has written:

> Because rights can be traded at any level of the IFLA model (works, expressions, manifestations, items), good descriptive metadata will not conflate these levels, and will provide for extensive, explicit linking between them.[79]

The principle of functional granularity leads to conflation because, with no requirement to define entities at any given level of abstraction, some descriptive metadata elements are repeated at all levels in order to accommodate selective entity description and enable identification at any level. Another consequence is that such identifiers as ISSN and DOI can be used to identify an entity at any level. Blurring the work/expression/manifestation hierarchy may appear to increase generalizability, but in fact compromises its value by introducing ambiguity into the meaning of the identifier because context must always be factored in. In a networked environment, the identifier associated with an object must not only be unique within the identifier namespace (a primary requirement of URNs), but also must operate within an unambiguous domain with unambiguous rules for identifier assignment. Lynch wrote:

> The assignment of identifiers to works is a very powerful act; it states that, within a given intellectual framework, two instances of a work that have been assigned the same identifier are the same, while two instances of a work with different identifiers are distinct.[80]

Two objects with different DOIs may be distinct, but nothing can be inferred about how they are distinct, whether they are two works or two manifestations of a work.

Assignment of an identifier only when a distinction needs to be made between entities (which themselves are incompatible with FRBR entities) implies that the assigner of the identifier is also the one determining the need. That need inevitably will be identified in the present and in the context of defined applications that use the identifier. Application developers seeking to refer to a specific bibliographic entity will find that identifiers assigned according to the principle of functional granularity are fundamentally ambiguous. The application will always need to ask, "for which data is it meta-?"[81] Paskin acknowledged this "shortcut"; for example,

in exchange for using a single identifier system at multiple levels of abstraction, one accepts that the difference between them is defined by qualification at the local, or application, level. He concedes that creation of a new identifier may be desirable rather than to accept this level of ambiguity in what is being identified:

> New identifiers may be needed and require the creation of a new namespace if the namespace currently being used cannot satisfactorily include a new type of entity without disrupting the existing business.[82]

He then cites the decision to create ISTCs as an unfortunate example.

Semantic convergence, that is, ensuring that the meaning of fields is not lost or changed when mapping between metadata schemes, is a broad challenge for metadata crosswalking. The principle of functional granularity, by associating the same identifier with entities at multiple levels that have overlapping attributes, as well as differently mapped entities, will make convergence of <in*d*ecs>-based schemes with schemes emerging from FRBR very difficult. The library community's response to the ISTC proposal pointed out that when ambiguity in the identification of fundamental entities such as the work exists, the identifier provided by the business model application for that entity is of little or no value for library systems. The Canadian response, for instance, noted:

> This fundamental difference as to the entities that are being identified and described . . . is a barrier to interoperability between ISTC applications and the library community. . . . As it stands, . . . the ISTC appears to be of limited use to libraries because of its incompatibility with *FRBR*.[83]

The principle of functional granularity also reveals the extent to which the intellectual framework that underlies <in*d*ecs>-based identifiers differs from what is needed by the library community. While both bibliographic control and intellectual property management require practical metadata schemes, they constitute different intellectual frameworks when it comes to descriptive metadata. Bibliographic control is concerned with describing intellectual works and manifestations in a manner that meets the anticipated needs of library users. Intellectual property managers are concerned with describing digital objects to meet the known and anticipated needs of rights holders. The divergence of audiences, goals, and time frames is not self-evident from the metadata itself, but is revealed by posing the question "When and for what purpose is the work described?" The economic incentives in intellectual property management are a strong driver of identifiers that adhere to the principle of functional granularity. As Hedberg said of ISTC:

> The strong connection to the publishing industry makes it evident that the ISTC is concerned only with those derivations where additional effort has been put into an existing work in order to publish it in a different format.[84]

A digital object described and labeled with an identifier for the purpose of an intellectual property transaction likely will not be adequately described as a bibliographic entity from the perspective of the cataloger.

The flexibility embodied in the principle of functional granularity ultimately reflects the priority of describing the attributes of a given object over its relationship to other, related objects. The <in*d*ecs> framework document spells this out:

> the point at which new abstract works or versions of works are identified is therefore imprecise, and subject to the principle of *functional granularity*. . . . Rights are one of the major drivers of functional granularity. For example, if a translation has different rights from the original work (which will almost certainly be the case), it must be identified as a distinct creation.[85]

The *DOI Handbook* restates the point: whether a publication is a new work or not "is a 'functional granularity' issue, and hence ultimately a decision for the publisher."[86] The group working on ISTC acknowledged that its objectives differ from those of libraries: "It might be necessary, for example, for the purposes of rights management, to identify something as a separate abstract entity when a bibliographer would not make that distinction."[87] The bottom line is that <in*d*ecs>-based identifier models are recording administrative—*not* bibliographic—metadata about the object, even where the attributes are descriptive in nature. In addition to being able to manage works across time, libraries must be able to do so across original and later publishers associated with a work. Publisher-centric administrative systems focus on relatively short-term business needs and reflect current relationships between the actors in the information distribution chain. A work identifier is needed that an author or libraries (particularly in the case of serials) could assign to a work and that would apply to all versions of a book, article, or journal independent of the current scholarly communication model and rights associated with each manifestation. If libraries again adopt an identifier with an administrative data model that is closely bound to the current business needs of publishers and distributors, the inevitable operational pressures will mean that, just as with

ISSN, interoperability will be advanced at the expense of basic principles of bibliographic control.

Possible Uses of the Work Identifier

Library Systems

In 1979 Gorman wrote, "The card catalogs in large libraries are a barrier to the use of the library."[88] The ensuing quarter century has seen card catalogs replaced by online catalogs that are still a barrier to the use of the library. This is particularly the case for users of our journal collections. Pinzelik pointed out that "[f]inding a serial in a large library can be an extraordinarily complex process, in which an inordinate number of decision points are met and opportunities for failure presented."[89] Our current automated linear catalogs, comprised of records cataloged principally at the manifestation level, favor the finding objective at the expense of the collocation objective. Despite the fact that we no longer need to choose one over the other, our online catalogs still support functions necessary only for card catalogs. At the same time, they do not support fundamental cataloging principles that support the second objective; for instance, main entry. Library users rightfully do not consider journal articles to be a lesser bibliographic class of intellectual work than books, and they have been confused by the seemingly artificial division of labor between catalogs and indexes. The quantity of journals and their share of library budgets have greatly expanded with the growth of postwar science and the serials pricing crisis. Their importance in teaching and research, particularly in the sciences, has grown as well. In addition, thanks to being available online and being aggregated in massive full-text databases, journals now are relatively more used by students than in the past. Although we have outsourced large parts of the bibliographic apparatus for journals, libraries still bear ultimate responsibility for making the whole package comprehensible to users. Our library users cannot yet come to the library's Web site with a citation in hand and easily find the full text, even when it is available there.

The potential of a serial work identifier can be explored without waiting for revolutionary changes to the cataloging code, to existing identifiers, or a new bibliographic data exchange format. Work can start where parallel, but more open and flexible, bibliographic systems already exist within our libraries. Separate electronic journal lists can be seen as an attempt to compensate for the weaknesses of providing access to journals from the catalog. The databases that drive these lists—often full-blown electronic resource management (ERM) systems—are potential sources of innovation because they are amenable to experimentation in ways that our current integrated library systems are not. These systems have the potential to improve upon typical OPAC displays, not just to include the paper versions (as some libraries already do), but to show users the bibliographic relationships among the journal manifestations. We must simultaneously use our displays to transmit the expertise of the librarian to help a user choose between available versions based on completeness of the text, file format, or other attributes.

The day when our catalogs can use the serial work concept may not be that far in the future. The integrated library system (ILS) itself becomes a possible realm for experimentation because many of the major systems ride on top of standard relational database management systems (RDBMS) such as Oracle. While the vendors may not store bibliographic data in a way that makes pulling it out for repurposing easy, given local programming support, doing so is still possible. The University of Buffalo has converted its catalog into XML using a MARC converter and the TextML indexer.[90] Several FRBRization tools now available from OCLC and the Library of Congress (LC) can help to open up a new realm for experimentation with the catalog.[91]

The work identifier also would have value for reference or citation linking. Populating OpenURLs with ISSNs does not work well for reference linking because, even if a match is found, the application can take the user to only one manifestation of a title. Reference-linking applications currently work around this problem by grouping the same titles using proprietary work-like keys based on title equivalency. This is another manifestation of the "appropriate copy" problem, which OpenURL systems were designed to address, in that users should be led to the appropriate copy of a work as well as the copy they are authorized to access. OpenURL metadata would benefit from the addition of a standard number for works. If a work identifier is associated with titles in the reference-linking database, the application could support either work-, expression-, or manifestation-level links, as well as appropriate data displays. Thus, the user would see the complete picture of library holdings and would or would not be offered services (such as catalog link, interlibrary loan) on the basis of those holdings. Applications such as jake, which shows which databases index a given journal and that must deal with sources representing that journal in any number of ways, also could use the work identifier behind the scenes to improve search results and displays.

Practical Issues

What would a serial identifier look like and how would it be assigned and used? While the specifics of a serial identifier is beyond the scope of this article, what it should look like and how it might be used can be envisioned in a general way. The work identifier should be a dumb number, unrelated to existing identifiers associated with the bibliographic entities that it describes, such as titles or ISSNs. To support systems

that link between manifestations using existing identifier schemes, the work identifier could be appended to existing identifiers, much like the options currently under review by the ISO review of ISSN, although the objective of the proposed ISSN extensions is to support being able to bring together all formats of a given *title*, not work.[92] Concern has been expressed about how such an identifier could be used in practice. Le Boeuf highlighted this concern, which stems from the abstract nature of the work and expression entities; he said of the work, "this entity hovers at such an abstract level that no standard numeric identifier in the world could ever grasp it. *Works* are just thoughts that have not yet been materialized, and thoughts are not numbered."[93] He is right. But in practice, as we have seen with the concept of bibliographic families, works would not be registered and assigned an identifier as they were created, but would receive one (assigned by the system, not the cataloger) only when they were embodied in a manifestation.

The availability within the FRBR model of two abstract layers, work and expression, is useful in modeling approaches to specific problems libraries currently face with serials. One problem is multiple copies of the same journal. The proposal for an aggregator-neutral record, which would include all issue-based electronic versions on a single record (and put article-based aggregator versions on a machine-derived record), can be seen to be a FRBR-like approach in creating different expressions of a journal.[94] In applying the identifier to serials under the FRBR model, the work identifier would bring together a collection of individual expressions and manifestations that were judged by the cataloger to be the same work. See figure 3 for an example of how a serial work might be modeled under FRBR. A change that did not constitute a new work would be one of these manifestations. A change that did constitute a new work would generate a work through the creation of its first expression and manifestation. Explicit relationships between the two works would then be recorded. Within the context of a library system, a work identifier could be used to bring together all manifestations held by the library, whether a "full serial" title or a title in an article database, in response to queries on title variants (including previous titles and abbreviations if the ERM was augmented with this data), ISSNs, or other access points. An interface could then be written to show the work once and display relationships between manifestations as well as associated holdings and other qualitative attributes that would assist the user in selecting the appropriate manifestation. See figure 4 for a potential outline of a catalog display for a serial work.

The strength of the entity-relationship model lies in its separation of the logic and principles of description from display issues. The ultimate solution would require not simply imperfectly grafting FRBR onto the current MARC/AAACR model, but making substantial changes to the cataloging code. As Le Boeuf points out, this is not a job for the ILS vendors. "The impact of structural relationships on OPAC issues *must* be dealt with in cataloguing codes."[95]

The Broader Network Context

Leveraging existing systems, in combination with emerging Web services technologies that support automated query of systems and data sources, could meet some of these broader goals. Existing and emerging protocols, such as the Web-services-based Z39.50 ("Zing") or Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), as well as research being done at OCLC on bibliographic databases

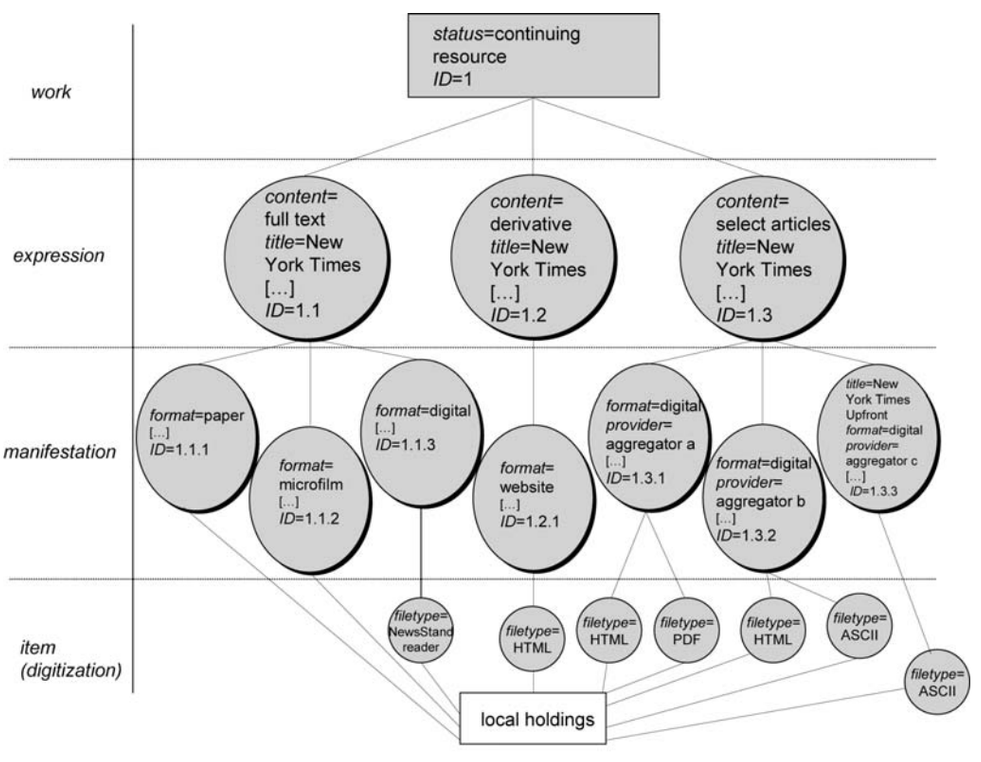

Figure 3. An example of a serial work within the FRBR model

and Web services, could also take advantage of a work identifier to achieve some of these goals.[96] The manifestation-level information in the ISSN database could potentially be FRBRized to create serial families or even a work-level identifier in much the same way that OCLC's experimental xISBN service collects individual records associated with a given ISBN to represent a work.[97] The ISSN Network has already piloted ISSN resolution services based on their metadata store. Because the Web URN infrastructure is not yet in place, a browser plug-in is needed, but the service is being built to use the URN framework. This direction has been made more promising with the arrival of a draft specification for an "info" universal resource identifier (URI) scheme, which would allow existing (legacy) identifiers to be coded using standard syntax that makes them usable by Web applications (for example, info:issn/03624331).[98]

Modeling uses of a work identifier in ways that would be helpful to users is important. Because our users are familiar and comfortable with the Internet, this means working within the framework of existing Web technologies and standards. We also should heed Cover's advice and not be "seduced or coerced into modeling parts of a problem domain in ways that are not natural or well-matched to the user's conceptual model of the problem space."[99] One such pitfall would be to limit our field of vision to the bibliographic record for the journal in isolation from the articles themselves and their lifecycle, the nature of which is changing as evolving scholarly communication practices provide user access to unpublished works and alternative sources for published works. In many ways, the simultaneous availability on the network of preprints, postprints, and publisher versions of articles parallels the availability within libraries of multiple versions of a given journal. The current world of networked information also should prompt us to take a broader view of the bibliographic record. Duke wrote of the "tripartite structure of the record," consisting of the document surrogate (the traditional bibliographic record), the document guide (a record enriched with content), and the document text itself.[100] Referencing the intellectual content of the work rather than, for instance, an authority record describing that work will support systems that could use the bibliographic and additional content information to provide the user with the context necessary to select the desired copy.

In the era of networked information resources, a library user's finding need extends beyond the domain of a catalog that represents a given library's collection. Catalogs, and by extension our collections, are underutilized as long as they exist only as self-contained systems that do not interoperate with nonlibrary systems and that require substantial understanding of arcane bibliographic practices. One conceptual model of the digital library is a distributed service. If digital library collections were made accessible via emerging Web services technology and supported actionable bibliographic identifiers, the valuable ontologies that libraries have developed and that are embodied in our authority files could be leveraged to advance the goals of the Semantic Web. We can take the lead from the development of the OpenURL and the OAI-PMH in two respects: first, in recognizing the importance of providing simple, easy-to-implement models to exchange bibliographic data on the network; and second, in prompting us to envision new user services that take advantage of explicit relationships between bibliographic works; for instance, to connect users with full text or additional information about a work or author.[101]

New York Times, 1851-present

Full Text online:
New York Times (via NewsStand)
2001- present *format*: NewsStand viewer

Selected Articles online:
New York Times (via aggregator x)
1999- present *formats*: PDF, HTML
New York Times (via aggregator y)
2002- present *formats*: HTML, ASCII
New York Times Upfront (via aggregator z)
1980- present *format*: ASCII
New York Times on the Web
past week *format*: HTML

Paper and Other Formats:
New York Times
latest 6 months *location*: Current Periodicals

New York Times
1851-2003
AN2 .N49 *location*: Microforms

Figure 4. Sample public catalog display of a serial work

Conclusion

The current catalog favors Lubetzky's first objective, finding a known item, over the second, finding works. If our catalogs are to become more work-based, we must revisit the question of what is meant by work for all bibliographic entities. Study of the bibliographic work has not yet confronted the challenge of conceptualizing and defining a serial work. The serial work is a bibliographic construct, a misfit in models such as FRBR, which strive for theoretical consistency across material types. Our current catalogs and Web title lists confuse users with multiple versions of the same serial, multiple access points to those titles, and absent statements about each version's important attributes. In order to make our bibliographic data valuable to scholars and others who seek works, asserting bibliographic control over a higher level of abstraction than has been our practice is necessary. We need to put a greater

emphasis on relationships between abstract entities and less on identification of the physical item. We need to better manage changes over time. The mutability we are accustomed to seeing in print serial titles we now also see in content, location, file format, holdings, and other attributes of online publications. If one accepts the proposition that value exists in controlling the serial at an abstract level and rejects the status quo premise that the "frail reed" of the serial title—or uniform title—can identify a serial work, other conceptual models, such as a modified bibliographic family, can be used in conjunction with FRBR to support a conception of a serial work.

In a networked information environment where the full-text item is a click away, links and hooks that increase access are relatively more important than description. Those links can only be supported by nonsemantic, nontextual identifiers for bibliographic works across domains. A number of such identifiers exist or are on the horizon, but they bring with them a very different model of bibliographic description than that held by librarians. Differently defined bibliographic entities, relationships between entities, and rules for assigning identifiers introduce a degree of ambiguity that poses significant challenges to library use of these metadata and identifier systems. Library catalogs describe and need to be able to refer to both intellectual works and manifestations of those works. They cannot, in an ad hoc way, describe one level and not another.

At this fluid time, we must continue to experiment, to whatever extent we can within the significant constraints we face, while focusing on the goal of improving the quality of bibliographic information we present to users. Bibliographic systems require persistence in human, not Internet, time. Library collections and, by extension, the bibliographic apparatus that supports them persist thanks to institutional commitment. This commitment is ultimately earned only through continued demonstration of value to library users.

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