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Extending the LRM Model to Integrating Resources

Trond Aalberg[a], Edward O'Neill[b], and Maja Zumer[c]

[a]Oslo Metropolitan University, Oslo, Norway; [b]OCLC Research (Retired), Dublin, OH, USA; [c]University of Ljubljana, Ljubljana, Slovenia

ABSTRACT

Integrating resources are distinct in that they change over time in such a way that their previous content is replaced with updated content. This study examines how integrating resources can be modeled using the entities and relationships of the IFLA Library Reference Model (LRM) and clarifies how they can be identified. While monographs have been extensively analyzed, integrating resources have received very little attention. Applying the model unmodified to integrating resources is neither practical nor theoretically sound. With the addition of two proposed relationships, the model can be extended to accommodate the diachronic relationship intrinsic between expressions and manifestations exhibited by integrating resources.

Before the age of e-publications and websites, the bibliographic universe was a simpler place. Library resources were divided into two groups; monographs and serials. Monographs were issued as complete units; serials were issued over time. Monographs were purchased individually; serials acquired by subscription. In a simplified view, monographs equated to books and serials equated to magazines and journals. Loose-leaf publications were a minor exception to this categorization as they exhibit characteristics of both serials and monographs–updatable books–which were categorized as "integrating resources." Whereas loose-leaf publications now are relatively rare, the growth of e-publications and websites exhibiting the characteristics of integrating resources make the understanding of this category of resources even more important.

Because neither the *IFLA Library Reference Model* (LRM) nor its predecessor the *Functional Requirements for Bibliographic Records* (FRBR) explicitly discusses integrating resources, they provide little guidance regarding how integrating resources should be understood and modeled using the bibliographic entities: works, expressions, manifestations and items. The modeling of integrating resources has rarely been addressed in the literature except as a

subcategory of continuing resources. There was a session at the 2019 IFLA General Conference and Assembly that focused on continuing resources but only the presentation by Zumer, Aalberg, and O'Neill focused on integrating resources specifically.[1] This study extends their work to: (1) clarify how integrating resources can be identified, (2) examine how integrating resources can be interpreted using the entities and relationships of the LRM model, and (3) model integrating resources using the entities defined in LRM. This study encompasses the common types of integrating resources with examples covering loose-leafs, e-publications, and websites.

What are integrating resources?

Integrating resources were formally recognized in the 2002 revision of the *Anglo-American Cataloguing Rules* (AACR2R) as a sibling category to serials under the common parent *continuing resources*.[2] They were defined as "a bibliographic resource that is added to or changed by means of updates that do not remain discrete and are integrated into the resource as a whole." The 2002 revision resulted in the following categories of issuance and revision:

- **Monographs** are revised by publishing a complete new updated version, usually called *edition*. While each new edition supersedes the previous one, they typically coexist with the previous editions. *Gray's Anatomy* is an example of a monograph that has undergone numerous revisions; the 41st edition is the latest edition. The first edition from 1858 is still available as are other editions.
- **Serials** are revised by adding a succession of discrete parts. A serial is updated by adding a succession of discrete issues containing articles and/or other significant parts. Although the content of the journal is frequently updated, the changes are appended to rather than integrated into the journal. The previously published content remains unchanged and available. *Cataloging & Classification Quarterly* is an example of a serial.
- **Integrating resources** are revised by updates that are integrated into the whole and do not remain discrete. An instance of an integrating resource is referred to as an *iteration*. New iterations do not change the identity of the integrating resource and previous iterations are assumed to be inaccessible. Several types of integrating resources are mentioned in the literature; loose-leaf publications, updating webpages, and databases.

There is broad agreement that integrating resources are, at least from the cataloging perspective, hybrids—a distinct resource type with characteristics of both monographs and serials. Hirons observed that integrating resources "is a new term for resources that are neither monographs nor serials."[3]

Young stated that the introduction of integrating resources recognized "the existence of resources that have the characteristics of both monographs and serials."[4] While integrating resources are similar to monographs, Miller and Robertson noted that they also "exhibit a high degree of seriality and have much in common with serials."[5]

Integrating resources are now cataloged according to principles shared by all continuing resources. The intention is to reduce the number of bibliographic records and changes in subsequent iteration(s) of an integrating resource do not require the creation of new bibliographic records. Instead, the previous bibliographic description is updated as necessary to reflect the current iteration and the information in the bibliographic record about the earlier iteration is moved to notes if considered important. New bibliographic records are, however, required when resources are merged, split, change format, switch media, or other similar cases.

The categorization based on mode of issuance introduced in the 2002 revision of AACR2 was continued in *Resource Description and Access* (RDA), the standard for descriptive cataloging, when it was first released in 2010. RDA was originally structured around the FRBR entities, but also bridged with AACR2 by incorporating many of the traditional conventions. In the latest LRM-based version of RDA, the term *continuing resource* is replaced by the notion of a diachronic work; "a work that is planned to be embodied over time, rather than as a single 'act of publication.' The essence of a diachronic work is a plan for the change of content. An extension plan describes the intended method for extending the content of a work through time."[6] The revised RDA describes two types of diachronic works based on the method that is used to update the content:

- **Extension by accumulation**: A successive work is a plan to accumulate content at intervals. Content for previous iterations of the work is retained. This process cumulates the content in successive expressions embodied by one or more successive manifestations.
- **Extension by replacement**: An integrating work is a plan to replace content at intervals. Content from previous iterations of the work is assumed to be inaccessible. This process integrates the content in a "single" expression that is embodied by one or more manifestations.

Extension by replacement corresponds with the previous concept of integrating resources but is now defined as an *integrating work*, a subtype of a diachronic work. RDA has a rather flexible definition of iteration defining it as "An instance of an integrating work or the expression that realizes it or the manifestation that embodies it. The instance may be the initial state or the state after an update."[7]

Integrating resource is used in this study as the preferred term. It is an established term recognized by the library community and is meaningful to a broad audience. The term also has the benefit of not being related to a specific entity in an information model. The term *iteration* is used here for any identifiable state of an integrating resource. Following an update, the new iteration represents the complete content, the unchanged portions as well as the revised portions.

Characteristics of integrating resources

Loose-leaf publications are the classic example of integrating resources. With loose-leafs, identifying integrating resources is straightforward; *integrated into the whole* means physically integrating the revisions into the previous iteration and thus transforming the resource. During the transformation, the previous iteration is consumed, rendering it unavailable in its previous state.

When integrating resources were introduced by AACR2, loose-leaf resources were still predominant, but now most integrating resources are e-publications or websites. In many cases, iterations are identified by the iteration number or the date of the update. However, in some cases, the updates are so frequent that the iterations can only be differentiated by the date they were accessed. What is common is that integrating resources retain their identity and previous iterations are assumed to be unavailable. Relying on a known form of issuance to distinguish between monographs and integrating resources is not very effective for e-publications or websites; identity and persistence are more effective criteria.

- **Identity** is a broad concept referring to how the resource self-identifies; its title, edition statement, uniform resource locator (URL), etc. If resource changes its public identity, this is an indication that it is a new edition of a monograph; if the identity does not change, that indicates that it is a new iteration of an integrating resource. For integrating resources, the identity is retained across all iterations.
- **Persistence** refers to the availability of previous editions. If the previous edition remains generally accessible after being updated, that is an indication that it is a new edition of a monograph; otherwise it is a new iteration of an integrating resource.

Examples of integrating resources

MARC 21 Format for Bibliographic Data

The loose-leaf version of *MARC 21 Format for Bibliographic Data* (Figure 1) was initially published in 1999 and was updated annually through 2007.[8]
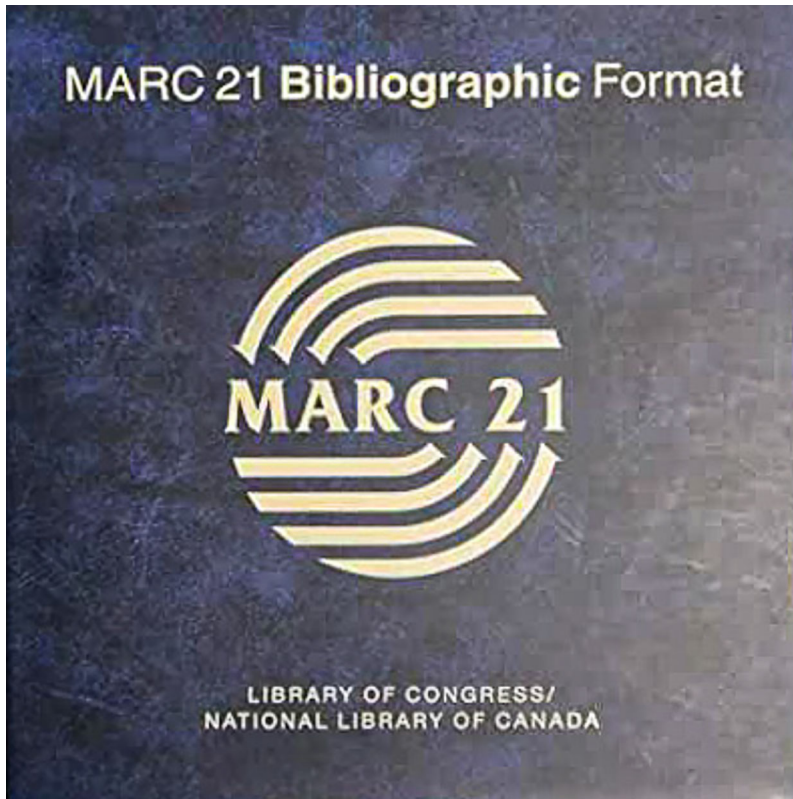
Figure 1. Cover of the loose-leaf MARC 21 Format for Bibliographic Data.

The physical items are in the form of three-ring binders containing loose-leaf pages. The original iteration was followed by eight annual updates resulting in nine distinct iterations. The first eight iterations of the manual are not generally available.

The MARC manual satisfies the classic definition of an integrating resource. The updates were integrated into the whole by physically adding and removing pages without producing new physical items. It retained its identity after being updated and previous iterations are no longer available.

WHO Coronavirus Disease (COVID-19) Dashboard

Updating websites are another common type of integrating resources which are frequently updated to remain current. The World Health Organization (WHO) provides current information about the COVID-19 pandemic.[9] The *WHO Coronavirus Disease (COVID-19) Dashboard* (Figure 2) is continuously updated, and the date and time of the last update are shown at the top of the homepage.

Relying on the form of issuance or the updating procedures to identify integrating resources is not particularly helpful for websites; the internal
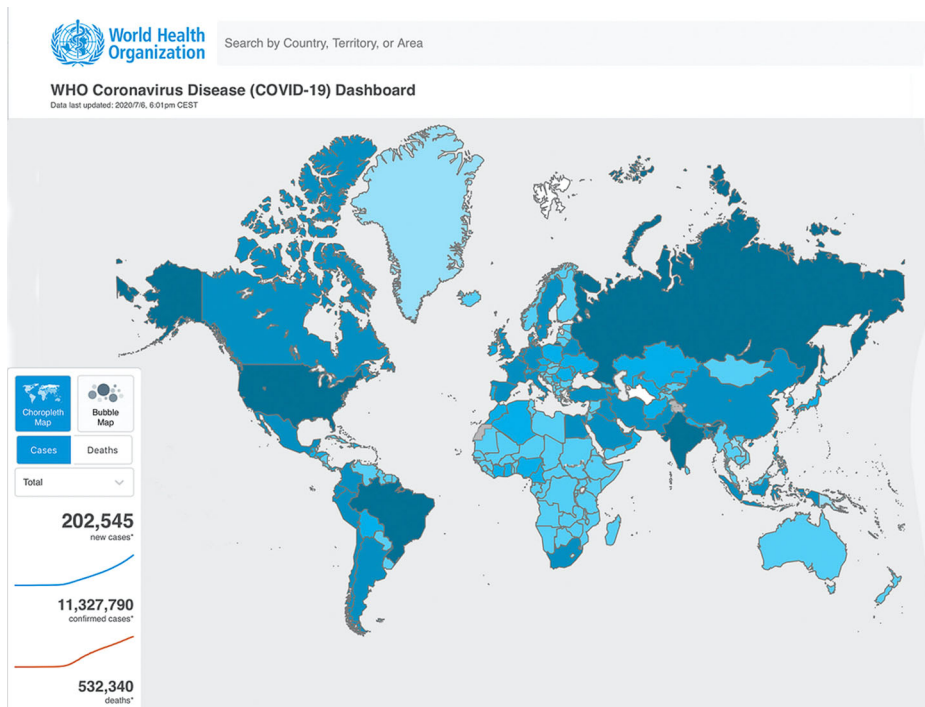
Figure 2. Screenshot of the WHO Coronavirus Disease (COVID-19) Dashboard.

updating procedures for websites generally are black boxes shielded from public view. However, the Coronavirus dashboard retains its URL after being updated and previous iterations are no longer generally accessible.

The Nikon Z7 Z6 Manual Viewer app

The Z7 is Nikon's first full-frame mirrorless camera. It was released in the fall of 2018 and was followed a few months later by the Z6. The two cameras share the same camera body and their controls and functionality are so similar that Nikon uses the same reference manual for both cameras. Like other advanced digital cameras, the Z7/Z6 cameras combine sophisticated electronics with advanced optics. Much like a computer, the Z7/Z6s utilize a programmable processor to control most of the camera's functions. Their firmware can be upgraded to add new functionality or otherwise improve the camera. When the firmware is updated, the manual is also updated to keep it in sync with the firmware.

   The Nikon *Z7 Z6 Reference Manual* (Figure 3) serves as a good example of a digital integrating resource. The manual was available via Nikon's *Manual Viewer 2*, a smartphone app.[10] Although Nikon has discontinued its support for the app, previously downloaded apps continue to function. Before the app was discontinued, Nikon had released three different

Figure 3. Nikon Manual Viewer 2 icon.

iterations of the manual corresponding to firmware updates. New iterations of the manual were downloaded on request rather than automatically. However, the app only supported a single iteration of the manual and the new iteration replaced the previous iterations.

In many respects, the camera e-manual's behavior is similar to that of the MARC manual; updating an individual item requires local action—replacing a page for the MARC manual and downloading the revised copy for the Z7 Z6 manual. Also like the MARC manual, once updated, the item exemplifying the prior iteration is physically transmuted to exemplify the current iteration.

Modeling integrating resources

The dynamic or updateable nature of integrating resources is not specifically discussed in LRM and the established entities and relationships are not well suited for recording the specific characteristics of integrating resources. Although it may be argued that integrating resources merely were a convention introduced for the purpose of systematic cataloging, they are a distinct group of resources that stand out in terms of how they are perceived by both library professionals and common users. Modeling of integrating resources using the entities of LRM, on one hand, needs to account for the general understanding of an integrating resource as one and the same entity, but on the other hand also needs to reflect the fact that multiple revisions exist over time.

The traditional way of cataloging integrating resources treats them similarly to monographs; a single work expressed as a single expression embodied in a manifestation. This is, however, a simplification that ignores the fact that multiple versions of a resource may exist and does not allow the recording of what a manifestation has embodied over time. Treating each individual iteration as a manifestation is not a realistic solution. Integrating resources are commonly understood to be specific publications where the identity is retained across iterations. It is also not scalable as many integrating resources have a large number of iterations and individual iterations do not need to be exposed to users in the same way as regular manifestations.

In LRM, a work is defined as an abstract entity representing the intellectual or artistic content of a distinct creation.[11] Expressions are also abstract entities representing a distinct combination of signs intended to convey the intellectual or artistic content of a work. Any modification or revision of the content will, in theory, result in a new expression. Manifestations are the embodiment of one or more expressions. Any deliberate changes that occur during the production process will result in a new manifestation. LRM specifically states that the content identified with a work can evolve as new expressions are created. Expressions and manifestations, however, are not described as evolving entities.

LRM does provide some flexibility when it comes to what constitutes discrete expressions and, consequently, manifestations. The amount and nature of changes allowed within the same expression will depend on the type of the resource and user context. For example, "minor changes, such as corrections of spelling and punctuation, etc., may be considered as variations within the same expression."[12]

When a new iteration of an integrating resource is embodied, the result should not be considered a new manifestation, but rather a new state of a manifestation that retains its identity. Sometimes this state is unknown and simply assumed to be the most recent. Integrating resources are generally described by a single bibliographic record, but the information about specific updates is often recorded as notes and, in practice, can identify and refer to a particular iteration or update.

RDA reformulates the classical understanding of integrating resources by introducing diachronic works. The idea that a work can be diachronic is, unfortunately, misleading. The same expression of a work can be embodied as both a monograph and as an integrating resource. The *Anglo-American Cataloguing Rules* was published both as a bound book (a monograph) and as a loose-leaf (an integrating resource). Initially, the content of the bound book and the loose-leaf will be identical. However, some later iterations may only be published as loose-leafs. Regardless of whether a work is

published as a loose-leaf or as a book, it represents the same work. The distinction between monographs and integrating resources is meaningful only after embodiment, i.e., for manifestations and items.

At the work-level, integrating resources are no different from other works. LRM does not consider works to be final or static entities. A major change, such as creating a movie from a book, will result in a new work. However, the updates represented by iterations do not require a new work to be instantiated. If a work has multiple expressions, this indicates that the work may have evolved. The iterations identified for an integrating resource are best considered individual entities at the expression level (if they are identifiable and there is a need to individually identify them). Although LRM allows some flexibility in defining the boundaries of expressions, it is obvious that an iteration identifies a specific state of the content and, as such, should be considered to be an individual expression.

It can further be argued that the specific nature of integrating resources primarily is at the manifestation and item levels. It is the manifestations and items that are diachronic; they can be updated without forming new entities. LRM makes it clear that that the production plan is an intrinsic part of the *manifestation*. "The production plan may involve aspects that are not under the direct control of the producer" including the requirements for maintaining the items by updating the items as specified by the producer.[13] This means that the production plan may include removing and replacing pages of a loose-leaf publication.

In order to cluster and sequence the iterations and to distinguish them from other expressions of the same work, the existing *Derivation* relationship (LRM-R24) could be used.[14] The derivation relationship is, however, a general type of relationship. To be able to distinguish sequences of iterations from translations and other types of derivatives, a more specific relationship is required. Adding the proposed *Next iteration* relationship shown in Table 1 would extent the model by clustering and sequencing iterations, enabling an explicit management of iterations.

The concept of a diachronic manifestation is also difficult to accommodate with the current model. LRM defines manifestation as "A set of all carriers

Table 1. Proposed relationship type for next iteration.

#	Domain	Relationship name	Inverse name	Range	Cardinality
LRM-R38	Expression	Is next iteration of	Is prior iteration of	Expression	1 to 1
	Definition	This relationship links an iteration to its subsequent version.			
	Scope notes	This is a refinement of the LRM-R24 (is derivation of) relationship, which creates a series of iterations. This relationship indicates that of two *iterations* of the same *work*, the second was used as the source for the first. These iterations are one at a time embodied in an integrating resource.			

Table 2. Proposed relationship type for diachronically embodied expressions.

#	Domain	Relationship name	Inverse name	Range	Cardinality
LRM-R37	Expression	is diachronically embodied in	diachronically embodies	Manifestation	M to M
	Definition	This relationship links a series of expressions (iterations) with the manifestations in which these expressions appear, one at a time, typically the latest available.			
	Scope notes	The same series of iterations may be embodied in different manifestations, for example manifestations in different formats. In addition to the iterations, the manifestation may embody other expressions, for example a foreword.			

that are assumed to share the same characteristics as to intellectual or artistic content and aspects of physical form."[15] As O'Neill and Zumer explain, "Significant changes to an expression's content will result in a new expression and consequently a new manifestation."[16] To allow for diachronic manifestations, this boundary restriction must be relaxed to permit replacing the iteration embodied in a manifestation without creating a new manifestation. To support the updatable nature of embodiment that is implied for integrating resources, another new relationship; a *Diachronically embodied* relationship is needed. This proposed relationship, shown in Table 2, can document sequential embodiment where a diachronic manifestation embodies multiple iterations over time. This is a distinct type of embodiment and should not be confused with static embodiment. The main difference from the static embodiment is that the diachronically embodiment is updatable.

Since the diachronic nature of a manifestation can be expressed using this specific relationship type, there is no need for a new entity type for diachronic manifestations. With respect to other attributes and relationships it is equivalent to the already existing manifestation type and, if needed, a statement that the manifestation is diachronic can be made using the LRM Category attribute (LRM-E4-A1). A generic example of this model is shown in Figure 4 where one work is realized through three different iterations (expressions) which are diachronically embodied in a single manifestation. At one point in time the manifestation diachronically embodies iteration n-1, but when the new iteration n is published the diachronically embodies relationship is updated to point to this.

Modeling the examples

The three examples discussed earlier will be used to illustrate how the revised LRM model can be applied to integrating resources. The earlier examples focused on a single manifestation. However, to illustrate how integrating resources can be modeled, other entities associated with the work also must be included. While non-English language expressions may exist, for simplicity, only the English language expressions and their associated manifestations are included in these examples.
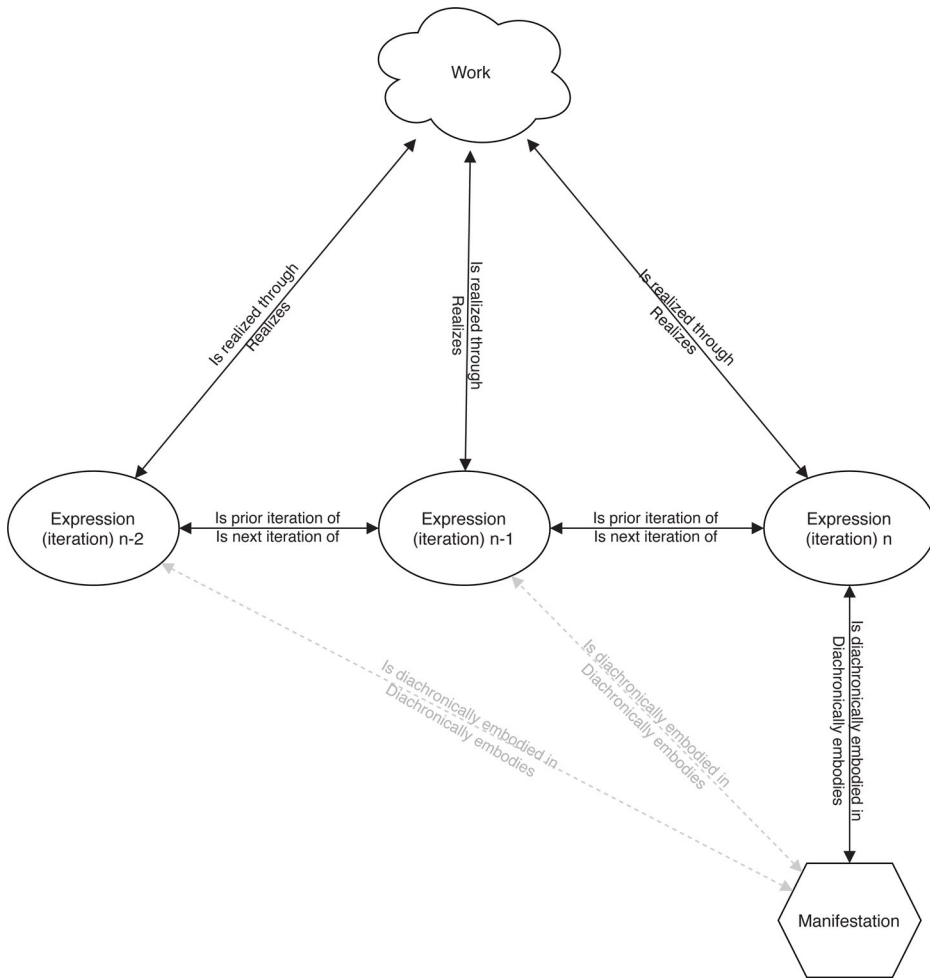
Figure 4. Proposed model for integrating resources.

MARC 21 Format for Bibliographic Data

In 1999, the Cataloging Distribution Service of the Library of Congress in conjunction with the Library and Archives Canada published the *MARC 21 Format for Bibliographic Data.*[17] This manual resulted from the merger of *USMARC Format for Bibliographic Data (1994 ed.)* and *Canadian MARC Communication Format for Bibliographic Data.* Although the new edition superseded and replaced the previous American and Canadian MARC manuals, the merger and revision were significant enough to be considered a new work.

In addition to the loose-leaf publication, this work was also published online (https://www.loc.gov/marc/). For the loose-leaf manual, the items are three-ring binders containing loose-leaf pages. The loose-leaf edition conforms to the classic definition of an integrating resource. While previous iterations may be of interest to researchers studying the development of the format, the vast majority of users seek the most recent iteration available.

The online MARC 21 manual is a combination of two manuals; a comprehensive version and a concise version. The comprehensive and the concise manuals share numerous sections including a common table of contents. This distinction is preserved in the online manual with separate element-level links. Many of the table of contents entries, including the *Introduction* and the *Leader,* provide two links: one to a comprehensive description and the other to a condensed summary. The online manual meets both the identity and persistence criteria for identifying integrating resources.

During the period that the loose-leaf manual was maintained, the two editions were updated annually, and the loose-leaf manual and the comprehensive version of the online manual were kept in sync. The loose-leaf manual, however, lacked the concise descriptions. Because of these and other structural differences, the loose-leaf and the online manuals are significantly different and should be considered different expressions. This is exemplified in Figure 5 where the iterations diachronically embodied in the printed version form one group of iterations (implicitly grouped with the *next iteration* relationship), and the iterations diachronically embodied in the online manual forms another group. The printed loose-leaf manual and the online manual are distinct publications.

WHO Coronavirus Disease (COVID-19) Dashboard

The WHO Coronavirus Disease (COVID-19) Dashboard is continuously updated to reflect the COVID-19 pandemic statistics (https://covid19.who.int). The frequent updating makes numbering each iteration impractical; the iterations are identified by the date and time of the last update. The iteration of the website shown earlier was identified as "2020/7/6, 6:01 CEST" (6:01pm Central European Standard Time, July 6, 2020). To accommodate the different time zones and data transmission methods, the website is typically updated several times a day. It is unclear exactly how many iterations of the dashboard have been generated but there have been hundreds and the number continues to grow, but only the latest iteration of the dashboard is accessible.

The information includes global statistics on the confirmed cases and deaths associated with the coronavirus. The information is presented, numerically and graphically, by region and country. While previous iterations are unavailable, all of the data is retained and detailed statistics, both daily and cumulative, are available through the current website. For example, drilling down in the website revealed that on April 3, 2020, Norway reported 270 new confirmed cases and 10 deaths.

The basic model for the instances of the Coronavirus Dashboard is shown in Figure 6. While the work has been realized by hundreds of distinct iterations, only the most recent iteration is embodied in a single
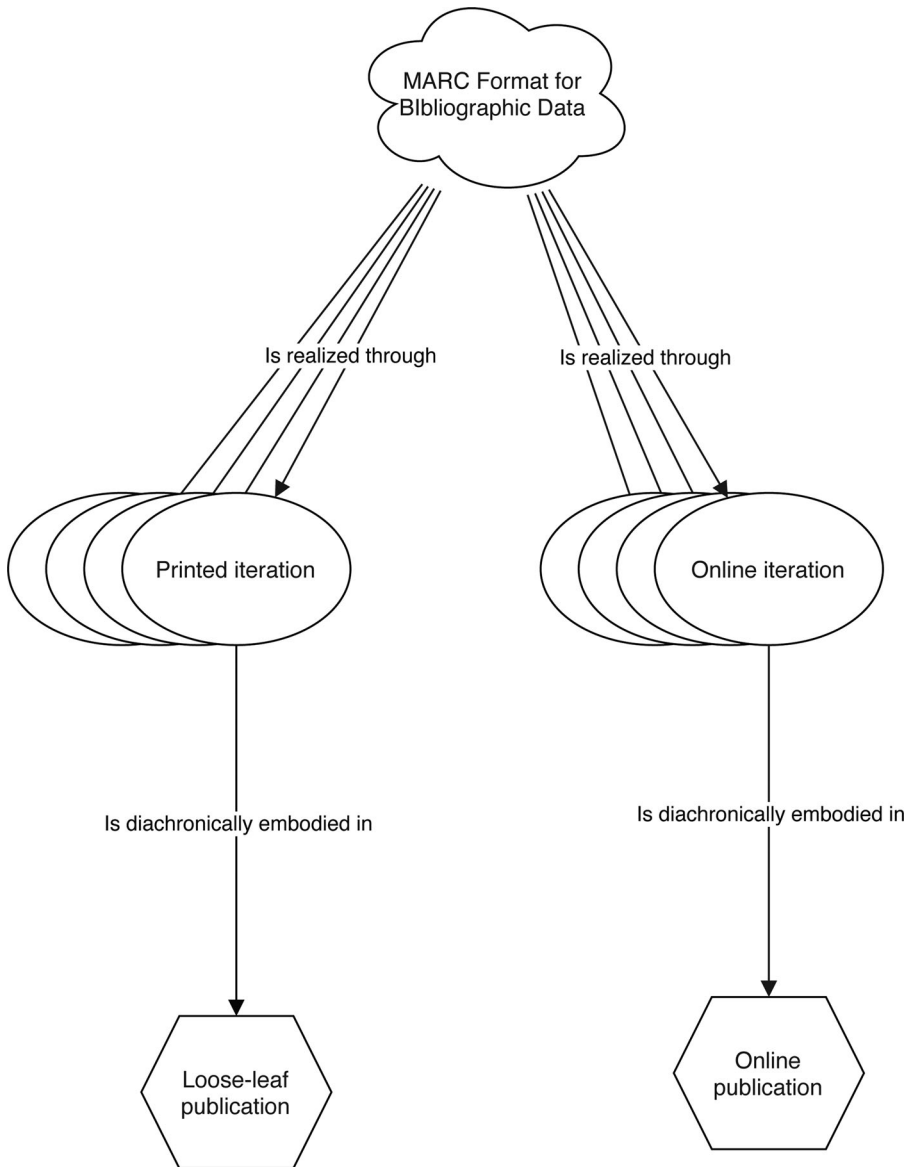
Figure 5. Modeling of the MARC 21 Format for Bibliographic Data.

manifestation. The Coronavirus Dashboard is clearly is an integrating resource, which can be modeled as shown in Figure 6. The WHO Corona Dashboard work is realized through numerous iterations (expressions) which all are diachronically embodied in the website (manifestation).

The Nikon Z7 Z6 Reference Manual

In addition to making the camera manual available through the discontinued smartphone app, Nikon also made the manual available as a downloadable
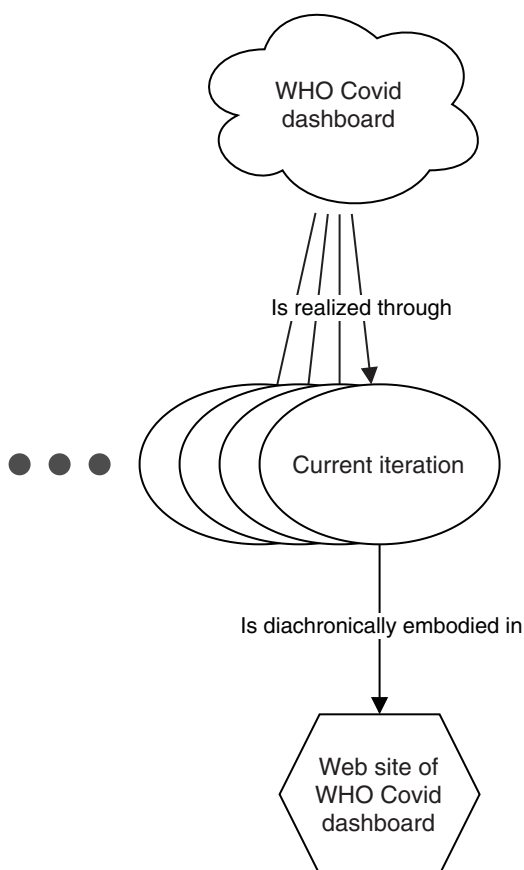
Figure 6. Modeling of WHO Coronavirus Disease Dashboard.

PDF and online in HTML format (https://downloadcenter.nikonimglib.com/ en/products/492/Z_7.html). While differing in format and access method, the three approaches provide the same information. While the exact policy on updates is not explicit, it appears that a new iteration is created when there is a major firmware update. Each of the updates is a distinct expression of the work. Nothing at the work or expression level differentiates the manual from a typical monograph. However, there are significant differences at the manifestation level; some manifestations are integrating resources while others are monographs as shown in the Figure 7 model.

The manifestation embodying an expression in PDF is the simplest to describe; The current manual is a 504-page document which can be downloaded from Nikon's website. While only the latest version is available on Nikon's website, earlier versions that had been previously downloaded can be retained locally. Therefore, the PDF should be considered a monograph and each update a new manifestation.

In contrast to the PDF manifestations, the online manual is embodied as an integrating resource. The online manual retains the identity across
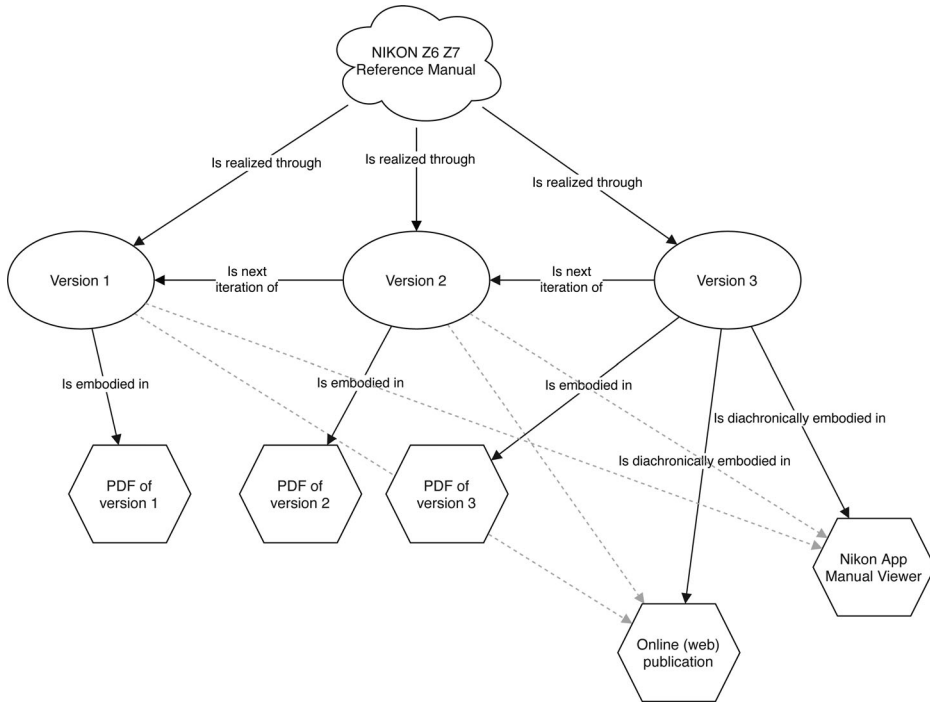
Figure 7. Modeling of the Nikon camera manual.

iterations and previous iterations are no longer unavailable. With the online manual, each update creates a new iteration. Unlike the PDF, each iteration is a new expression embodied in the existing manifestation. An interesting aspect of the camera manual is that as a work, it is embodied both as a monograph and as an integrating resource confirming that the dynamic nature of integrating resources is not an expression or work level characteristic.

Conclusions

An integrating resource can change over time in such a way that the previous contents become inaccessible. They are a distinct type of bibliographic resource; different from either monographs or serials but with characteristics of both. The traditional view of integrating resources must be revised to accommodate e-publishing. Identity and persistence provide a more effective means to distinguishing between integrating resources and monographs than relying on the physical mode of issuance.

Applying the LRM model focused on monographs to integrating resources is neither theoretically sound nor practical. RDA introduced the concept of a diachronic work—a work that is embodied over time—as one approach to accommodate integrating resources. However, referring to works as diachronic is misleading—any work can be, and often is,

developed over time. The same expression can be embodied as both a monograph and an integrating resource. Works and expressions are neither diachronic nor static—this distinction is meaningful only for manifestations and items.

Integrating resources are not explicitly discussed in either LRM or FRBR and minor changes to LRM are required to accommodate them. The view of manifestations must be revised to permit the embodiment of different iterations over time. Two new relationships are also needed to accommodate the diachronic relationship between iterations and manifestations. With these relatively minor revisions, the LRM model can accommodate integrating resources as well as monographs.

In this paper we focused on integrating resources. Other examples of modeling complex structures, such as aggregates and serials would also need attention in the future.

Funding

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