The Archival Photograph and Its Meaning: Formalisms for Modeling Images

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This article explores ontological principles and their potential applications in the formal description of archival photographs. Current archival descriptive practices are reviewed and the larger question is addressed: do archivists who are engaged in describing photographs need a more formalized system of representation, or do existing encoding schemes and description standards provide enough foundation and structure? The emerging semantic Web 3.0 environment presents new challenges. Ontology, formalizations, semantic annotations, and effective machine processing are of immediate and practical importance. To begin exploring these concepts within the context of archival description, a new semantic archives model is proposed.

KEYWORDS archival description, archival descriptive standards, photography, photographic collections, knowledge representation, ontology, knowledge bases

INTRODUCTION

The following statement, taken from Victor Burgin’s Thinking Photography, addresses the relationship of text to the photograph, and is worth quoting at length:

We rarely see a photograph in use which is not accompanied by writing: in newspapers the image is in most cases subordinate to the text; in advertising and illustrated magazines there tends to be a more or less equal distribution of text and images; in art and amateur photography the image predominates, though a caption or title is generally added. But the influence of language goes beyond the physical presence of writing
as a deliberate addition to the image. Even the uncaptioned photograph, framed and isolated on a gallery wall, is invaded by language when it is looked at.¹

Many individuals are engaged with describing photographs, including critics and curators of the photograph,² philosophers interested in aesthetics,³ ethnographers using photographs in social research both as data and data generators,⁴ photographers describing their work,⁵ and archivists describing archival photographs in finding aids and item-level records.⁶ This article explores the principle systems used by archivists for describing photographs. By reviewing how archivists describe photographs and the tools they use for representing descriptions, an attempt is made to discover what role, if any, archival representation plays in assigning meaning to photographs. Concurrent with the evolution of archival representation there has been an attempt in artificial intelligence (AI) to represent knowledge itself. This essay examines the differences between archival representation and systems of knowledge representation when applied to the photograph. It explores whether finding aids and item-level records provide sufficient degrees of expressiveness and formality in representing the meaning of photographs or whether a more formalized system of representation is needed, especially in light of the emerging Web 3.0.⁷ In the process of examining the myriad archival encoding and description standards and AI’s levels of knowledge representation there lies the possibility of uncovering a new framework for understanding knowledge representation in the context of archival description.

OVERVIEW OF THE ARCHIVAL PHOTOGRAPH

The existing literature on archival photographs is vast. To help focus the analysis and understanding of the literature as it pertains to this article it is helpful to organize this literature into a few general categories. Using Photographs: Archival Care and Management (2006) as a framework for discussion,⁸ the management of photographs passes through various stages of archival work as shown in Figure 1. The following analysis focuses on one functional

![Figure 1: Photographs Pass through Several Stages of Archival Work before They Become Available to Researchers.](image)
The act of describing originates during the initial phases of archival work. It begins during accessioning and arrangement when the archivist records information relating to collection title, dates, administrative history, biographical information, scope and content, organization and arrangement, and so on. In the Australian *series* approach, engagement with records may begin even earlier, focusing on provenance and context. These concepts lie outside the boundaries of the recorded document, focusing on relationships between creators, functions, activities and record-keeping systems. Description eventually manifests itself in the form of finding aids, calendars, registers, inventories, and other forms of representational artifacts during the “description and cataloging” stage shown in Figure 1. The following section explores how archival description and arrangement has been defined in the literature.

**Defining Archival Description**

In his essay “A Few Remarks on the Lens, the Shutter, and the Light-Sensitive Surface,” David Campany considers why photography attracts definition. The need to define something, he argues, “happens when we are attracted to it, or when we find it threatening, when it is disappearing from us.” Campany adds, “The more elusive the photograph is, the greater the wish to pursue it.” Perhaps this is why archivists have a penchant for defining archival description and debating its purpose. The topic is elusive, threatening and disappearing, or perhaps not disappearing as much as calling out for radical change.

Luciana Duranti, in an article exploring the origin, meaning, and evolution of archival description, explains that that term means “writing about archival material.” She tracks the meaning of archival description over a period of eighteen years, beginning with the Society of American Archivists’ (SAA) glossary of terms published in 1974. Archival description was then defined as “the process of establishing intellectual control over holdings through the preparation of finding aids.” Long before this, the Dutch archivists Muller, Feith, and Fruin conceptualized and codified the meanings of description and arrangement in *Manual for the Arrangement and Description of Archives* (1898). They placed constraints on level of description, suggesting that it should provide an outline of the collection and not a description of the contents of the documents in the collection. “The guide to the archival collection,” they stated, “must not seek to make consultation of the collection itself superfluous.”

Theodore Schellenberg reinforced this principle when he described the researcher as someone who wants to know something about the entire holdings of a collection. He suggested that archivists “should thus describe his
entire holdings immediately in summary finding aids consisting of guides and catalogs in which descriptions are provided of record series within large or significant groups and collections,” and he advised them to “forgo the detailed description of individual record items until he has provided a comprehensive description of his holdings.”\(^\text{15}\) Contrast this to Kenneth Duckett’s advice to archivists to perform extensive background research before beginning and then carefully unpacking materials and keeping formal note cards for items or groups of items.\(^\text{16}\)

In her article, Duranti next introduces a definition developed in 1989 by an SAA working group who defined description as “the process of capturing, collating, analyzing, and organizing any information that serves to identify, manage, locate, and interpret the holdings of archival institutions and explain the context and records systems from which those holdings were selected.”\(^\text{17}\) This definition became the basis for Fredric Miller, who highlighted the process-oriented and content-oriented nature of description in his 1990 SAA manual on arrangement and description. He defined description as “the process of capturing, collating, analyzing, controlling, exchanging, and providing access to information about (1) the origin, context, and provenance of different sets of records, (2) their filing structure, (3) their form and content, (4) their relationship with other records, and (5) the ways in which they can be found and used.”\(^\text{18}\) Duranti explores other definitions, concluding with a context-based definition in use by the Canadian Working Group on Archival Descriptive Standards in 1985: “Description is a major function in the processing of archival material, and the products of this function are finding aids of various sorts which give administrators control over their holdings and enable users and archivists to find information about particular topics.”\(^\text{19}\)

To bring the discussion full circle, it is worth mentioning Richard Pearce-Moses’s most recent definition of description published in the 2005 edition of *A Glossary of Archival and Records Terminology*: “The process of creating a finding aid or other access tools that allow individuals to browse a surrogate of the collection to facilitate access and that improve security by creating a record of the collection and by minimizing the amount of handling of the original materials.”\(^\text{20}\) It is tempting to say that after many years of discussion about what archival description means, a muddled definition has been placed on the table.

**Relationship between Description and Arrangement**

When discussing description, archivists relate this important archival function to that of arrangement. As Kathleen D. Roe states, the practice of arrangement and description are unified tasks, constructs inextricably intertwined that apply structure and meaning to materials housed in archives.\(^\text{21}\) She describes this unique relationship as a process of physically organizing records...
based on an understanding of their intellectual structure. Even though arrangement and description share a close relationship, they describe two distinct processes. Arrangement is the intellectual process of identifying and bringing together sets of records, records that share a common source and common characteristics and structure. Where description creates a representation of the records, arrangement identifies relationships between records and between records and their creators.22

Provenance and original order govern both arrangement and description. They are the overarching principles that determine how archival collections are processed and how archivists arrange and describe collections. The principle of provenance is identified primarily with the creator and dictates that a body of records must be linked to its creator and not mixed or combined with the records of another individual or organization.23 The concept of original order establishes the organic nature of records and that their internal structure and arrangement, as established by their creator, “are to be maintained in the order and with the designations which they received in the course of the official activity of the agency concerned.” 24 According to the Canadian Rules for Archival Description, the principle of respect des fonds incorporates both provenance and original order, directing that “the records created or accumulated by one records creator must be kept together and not intermixed with the records of other creators” and “the way archives are described depends on their arrangement. Implicit in the archivist’s observance of respect des fonds is the assumption that the way a creator ‘automatically and organically created and/or accumulates records’ will affect the way archivists arrange a fonds.” 25

The aforementioned principles are concerned with two kinds of information: record content and information derived from the context in which the records are created. As Roe states, “Records have content, thereby providing specific factual data as well as attitudes and views from a particular person’s or organization’s perspective.” 26 The inventory of 3M Company’s corporate records held at the Minnesota Historical Society demonstrates that records also say something about the context in which they are created.27 For example, the records relating to Richard G. Drew (1886–1982), inventor of masking and Scotch tape, contain factual information on his service at 3M Company. The context in which these records were created—records that sometimes consisted of audiotapes of reminiscences—provide insight into his life as an inventor throughout most of the twentieth century.

DESCRIPTIVE MODELS FOR PHOTOGRAPHIC MATERIALS

Three concepts emerge from the preceding discussion on archival description and arrangement that apply to photographs: (1) process—the process of appraisal, taking possession of photographs, accessioning, collating, analyzing,
FIGURE 2 In the Traditional Archives, Acquisition and Processing of Collections and the Relationship Between Archival Arrangement and Description are Grounded in the Principles of Provenance and Original Order.

classifying, preserving, and storing photographs; (2) *purpose*—the purpose of providing administrative control over collections of photographs and providing researchers with access and retrieval capabilities; and (3) *product*—creating representational artifacts including finding aids, index cards, inventories, and other devices for describing content, location, provenance, original order, and context. A diagrammatic view of these concepts and their relationships presented in Figure 2 can be translated as follows: The archivist appraises and acquires photographs created by an organization or individual. The archivist gathers and records information about the photographs during every phase of their management including the appraisal process. Description-related processes may continue throughout the life of the record and cover every element of information no matter at what stage of management it is identified. The archivist, whose work is shaped by the principles of provenance and original order, ensures that the records are not intermixed with the records of other creators. The archivist maintains the internal structure and arrangement of the records, arranges and describes the record collection, and then creates a finding aid, inventory, calendar, catalog record, or other representational artifact that informs researchers of the archival depository’s holdings and assists researchers in locating materials.
In this traditional model, “the archivist’s role in relation to records is to reveal the meaning and significance—not to participate in the construction of meanings—through the exercise of intellectual control.”

The focus now shifts to the representational systems archivists use for describing photographs and photograph collections. Special attention is given to two data structures: the catalog item-level record and the finding aid. Both data structures are used in contemporary practices and continue to be produced in both paper-based and digital formats. Finding aids are generally used for collection-level descriptions, but in special circumstances have also been used to describe a single item. In using these data structures, archivists have not been concerned with the conceptual landscape of the photograph or with formalizing its meaning. Instead, archivists generally focus their attention on the syntax of record building and the business of developing standards for constructing syntactically accurate and consistent descriptions of photographs and photographic collections.

**Item-Level Description: The Bibliographic Record Model**

Online public access catalogs (OPACs) have replaced most library card catalogs in the United States. Through a process called retrospective conversion, paper-based card catalogs are converted to MARC (machine-readable cataloging) records. It is a relatively easy process to accomplish with library collections because libraries can go to large bibliographic utilities, such as OCLC and copy preexisting MARC format records needed for bibliographic and authority data in their new online catalogs. It’s a different situation for archives. Archives are collections of unique, one-of-a-kind items and cannot benefit from copy cataloging. Consequently, many archives still maintain card catalogs—fondly referred to by Richard Cox and colleagues as “artifacts of library history.”

Evidence of the card catalog’s continuing relevance can still be found in small liberal arts colleges like Washington and Jefferson College in Washington, Pennsylvania. There the Learned T. Bulman ’48 Historic Archives and Museum houses items relating to Washington and Jefferson College and its history along with a large collection of manuscripts and other material relating to eighteenth and nineteenth century United States history. Samples of current, typewritten subject cards describing photographs are shown in Figures 3 and 4. As these cards readily demonstrate, paper-based catalogs offer limited information about photographs. No information is offered regarding the format, size, photographer’s name, and so on. In some instances, access to the catalog itself is limited. The card catalog from which these samples were taken is located within the archives, which is a locked facility within the main library.

The cards shown in Figure 4 are more abbreviated than those shown in Figure 3. The subject is simply “Washington College,” which could mean...

it is a long view (in terms of distance from camera to subject) taking in the entire campus, or the photograph may show only Old Main, the centerpiece of the campus. Many details are left unrepresented on the card.

It is not unusual for catalogs of this nature to lack authority control, which in turn affects accessibility. Robert H. Burger, in examining the role of authority control, notes that authority control is directed at access points in catalog records and that the access points must be unique and consistent.\(^31\)

Whiskey insurrection (Figure 3) may be consistent within this archives’ catalog, but it is not consistent with, for example, the Library of Congress subject heading authority, which lists *Whiskey Rebellion, Pa., 1794* as the correct subject heading. Helen Schmierer, in a study about the relationship of authority control to the library catalog, identifies two general purposes of a library catalog: (1) the library catalog should enable a user to ascertain if the library has a particular item, and (2) the library catalog should show what items the library has that share a common characteristic.\(^32\) In the sample cards shown in Figure 4 there are no logical connections made between these cards or any of the other materials in the collection that share the same subject. Another example of missing links is shown in Figure 5.

The point here is simply to recognize that paper card catalog systems still exist; they are used by archivists to describe archival photographs and other materials, and the semantics of a handwritten or typed card is not accessible to machines, only to people.

The Hoover Institution Library and Archives at Stanford University provides an example of the card catalog model adapted to an online catalog. Most of the library’s original card catalog descriptions have been converted to MARC and can be searched using Stanford University Libraries’ online catalog Socrates.\textsuperscript{33} The following search was entered as a query in the online catalog:
The query returned a record that describes a collection titled “O.É. Tuganova papers, 1906–2006.” The OPAC view is a typical, user-friendly translation of a MARC record. Behind the scenes in the underlying MARC record each line is given a name and assigned a unique number. The line labeled “title,” for example, is assigned a unique tag number 245. A computer system that supports MARC reads the various tags and knows in what field to display the appropriate matching information. It reads 245 and displays the data in the title field. The physical description of these papers is at the collection level and lists “12 ms. boxes, 1 oversize box.” There is no evidence given regarding the nature or characteristics of the individual photographs contained in the collection such as photographer’s name, dimensions, or format, and there are no descriptions. The abbreviation “ms.” may mean “manuscript” to some searchers and to others it may not mean anything. The summary field provides a hint that there is only a single photograph represented by this record with a general indication of the photograph’s subject: Soviet Union.

Joan M. Schwartz warns that in adopting bibliographic models such as these for image classification the archivist necessarily focuses on factual content. Schwartz believes that the structure of bibliographic records disallows representing the functional origins of visual images. She cites this as the reason archivists “fail to engage fully with new and exciting ideas about representation and reality, context and meaning.” Schwartz argues there is a relationship between users’ appreciation for archival photographs and the standards applied by archivists when describing photographs. Schwartz discusses at length a phenomenon she calls linguistic othering, in which textual materials are taken as the norm and photographs, which are non-textual, are viewed as the archival “other.” Schwartz’s arguments against using bibliographic records to describe photographs can be extended to the search syntax researchers choose when querying an archives’ databases. In the earlier example searching the Hoover Institution Archives, given the nature of bibliographic indexing systems where only certain access points are made available, the syntax used to query the online catalog consisted of only two atomic statements: Subject is Russian and ContentNote is photograph. It wasn’t so eloquent as “Show all of the black and white gelatin silver prints depicting social conditions in early twentieth century Soviet Union.” As an experiment, this declarative statement was entered as a search in Socrates, and the system reformatted the question and provided an answer in one fell swoop:

SEARCH+EVERYTHING “Show and all and black and white and gelatin-silver and prints and depicting and social and conditions and in and early and twentieth-century and Soviet and Union” found no matches in any library.
The machine was unable to process the query effectively. Since the search results were an empty set, the system attempted guessing the intended meaning of the query and provided as an alternative some possible see references including show biz, show business, show cards, and show horses, among other topics. The irrelevance of these suggestions demonstrates a major drawback in using representational systems that focus on matching search terms with index terms as opposed to semantics and machines that are capable of processing information effectively. Humans know what is meant by the query “Show me all of your black and white gelatin sliver prints,” but to a machine it is meaningless. In online catalogs that encode data in MARC the machines process tagged retrieval points in records—a name, keyword, subject, phrase, or some other code it can use for searching and identifying what it decides is a relevant archival description. In spite of its shortcomings, the catalog is a dependable workhorse for minimal levels of intellectual control over collections.36 Ruth B. Bordin and Robert M. Warner, in their manual for manuscript libraries, strongly agree: “The great advantage of the general catalog is that it works equally well for a collection of 800 feet or a single item. The larger collection will need a larger number of added entry cards and will take much longer to catalog ... but the same methods are equally appropriate for both.”37

Collection-Level Description: The Finding Aid

When Richard Cox wrote “writing effective finding aids is a complicated business,”38 he was asking whether anyone really understood what archival finding aids say to researchers. While there is a note of irony in his statement, it should matter that finding aids are hardly treated as simple descriptive architectures in Cox’s article. He questions why the finding aid, the preeminent model for describing archival materials, has not been the subject of more controversy. Cox comments, “it seems unlikely that they can represent effectively all the layers, details, nuances, and vagaries that constitute records.”39 Steven L. Hensen reduced the role of a finding aid to a simple fact nineteen years earlier when he said “If there is a practical equivalent to the bibliographic title page, it is the archival finding aid.”40 Archivists have failed to seriously investigate users of archival materials, what questions searchers ask, what kinds of information searchers seek, the formats they prefer, or the time frames in which they expect delivery of information. It isn’t clear to anyone what finding aids say to researchers or whether it is necessarily useful.

It can be assumed, however, that after many generations of use, researchers generally understand the nature of library catalogs, digital or analog, and the fact that they are access tools pointing to monographs, serials, or bound periodicals setting on bookshelves. Integrating EAD (encoded
archival description) finding aids into library cataloging systems demands a different mind-set, a different kind of conceptualization on the part of researchers. Finding aids are a catalog-like structure within a catalog. A finding aid does not use a call number to point users to a single item on a shelf. When searchers retrieve a finding aid in an online catalog they are looking at a document that describes a collection of materials contained within an archives group, fonds, or historical collection—an assemblage of materials that may represent thousands of items stretching for hundreds of linear feet stored in files and boxes.

Retrieving a finding aid using an online catalog can be a challenge in itself, a process of serendipitous discovery, unless a researcher can limit the search results to a record type of “finding aid.” That is not an option in the University of Pittsburgh Library System. The scene that is about to be described is not unique to this university’s archives but can be found in many university and college archives, large and small, public and private. The best hope for accessing a finding aid in University of Pittsburgh’s library system is by either locating the three-ring binders that hold hardcopies of typewritten and word-processed finding aids or by using PITTCat, the Library’s OPAC that provides links to finding aids formatted in EAD. To accomplish the former, researchers must ask a reference librarian in what locations paper-based finding aids can be found. To accomplish the latter, researchers must formulate a keyword search that includes the term “finding aid” or otherwise prepare for a fortuitously long journey browsing through multiple menu items to locate a dedicated finding aid search engine.

There is one particularly large photographic collection in the University Archives Service Center titled Collection of the Pittsburgh City Photographer, which is described by an archival finding aid. The finding aid can be found in PITTCat by entering a Boolean conjunctive keyword search: finding aid AND Pittsburgh photographer. This search returns a small set of five results, one of which is the finding aid for the collection in question. The abstract of the finding aid informs searchers that the collection consists of approximately 150,000 photographs and negatives, “excellent building, transportation, industrial, housing, and peripheral details of the history and development of Pittsburgh.” The full text of the finding aid includes a “Collection Scope and Content Notes” statement and within that statement the archivist provides examples of only three photographs: the 1905 construction of the filtered water reservoir, the 1911 North Side flood district survey, and the 1912 excavation of the “Hump.”

One cannot help but ask what it is that systems librarians and archivists fixate on when building well-intentioned systems like this. Richard Cox was justified in asking, “Is there anything natural in how archivists construct finding aids, except for the millennia old tradition of making lists that date back nearly to the beginning of writing?” Atul Nerkar, professor of management at the Columbia Business School, shares an old story about a drunk who
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has been in a bar all evening and on his way to his car he realizes he has lost his keys. “So he’s walking back to the bar, looking for his keys, but it’s pitch-dark and he can’t see anything. Along the way there’s only one light, coming from a lamppost. He could have dropped his keys anywhere, but he keeps searching under the lamppost because that’s where the light is.”

In a similar way, archivists keep returning to the finding aid as the basis for designing new representations for digital archives accessed on the Internet. Paraphrasing Nerkar, “archivists tend to look for solutions, or new knowledge, in the neighborhood of existing expertise.” They keep searching for answers in finding aids because that is what they understand best.

Before leaving the finding aid it should be recognized that EAD is the de facto standard for encoding finding aids. Most EAD finding aids are encoded in XML (extensible markup language) and defined by a DTD (document type definition) or other schema. XML in combination with DTDs offers a significantly richer language for describing archival photographs and photographic collections. However, as with paper and online card catalog systems, the semantic information in XML-based finding aids is not machine accessible in conformance with the semantic Web vision as expressed by Tim Berners-Lee and others. The semantics of an EAD finding aid is only accessible to people.

DESCRIPTIVE STANDARDS

Thus far this article has explored what archival description means, what its role is in describing archival materials, and two common models used for presenting descriptions, namely the catalog record and finding aid. It has become evident in the process that archival description and the architectures for representing descriptions evolved from a tradition of describing bibliographic and text-based materials. There is a general reluctance to recognize the unique and complex nature of archival photographs, collections, and image-constructed knowledge.

Now it is time to explore the description process from another viewpoint based on the rules and standards that govern how archival information is represented. Generally speaking, all of the rules that guide archivists in cataloging materials fall under one or more of these three headings: (1) Data Structure Standards, (2) Data Content Standards, and (3) Data Value Standards.

Some institutions use custom-built descriptive models rather than using nationally or internationally based standards. The current card catalog at Washington and Jefferson College discussed earlier is an example. In a survey of European institutions conducted during 1998 to 2000, it was shown that of the 141 respondents who together manage a total of about 120 million photographs, “only a small minority use standard models developed
It isn’t known how many nonstandard systems are in use around the world or to what degree they are interoperable. Not only do standards help establish consistency across cataloging entries within a system, but if they are broadly accepted, they enable disparate, heterogeneous systems to search and access one another’s collections. Since there are many standards from which to choose, archivists generally decide on one that they will adopt as a standard for their organization. Depending on the standard chosen, the archives may be complicating matters by adding another layer of non-image-related descriptive elements to the final representation. For example, the Biblioteca Nacional de España adopts the non-photographic descriptive standard known as ISBD and combines this with the MARC format. The result is photograph-specific information entered into a non-photographic-based model. When nonspecific systems are used to describe photographs, “cataloguers may be forced to stretch the meaning of elements to squeeze in information that is specific to photographs.” This stance was strongly reinforced by Gigliola Fioravanati, Director of the Italian Center for Photoreproduction, Binding and Restoration (CFLR) who said, “[D]espite the fact that the law on the protection of cultural assets includes photographs among items to be protected and preserved, numerous bodies in Italy have still to formulate a policy and action plan for the conservation and promotion of photographs as items of culture heritage.” Fioravanati went on to say, “The descriptive standards in use for other types of records are applied to photographs, and a specific standard is very rarely used, even when its characteristics have been identified.”

The most common standards and their applications in item-level and collection-level descriptions are briefly discussed in the sections that follow. Some of these standards are used for describing individual photographs and photograph collections even though the standards were never specifically designed for these purposes. The first category addressed is data structure standards.

Data Structure Standards

Data structure standards define what data elements are included in a system and can be transmitted and read by other systems supporting the same standard. Data structures such as MARC 21 and EAD using DTDs, already discussed elsewhere in this article, rely on data content standards and data value standards for much of their content.

Metadata as a Model for Describing Photographs

There has been slow, wavering progress made in building better models for describing photographs using metadata structures. The term metadata is usually defined in just three words: data about data, a definition that
“provokes more questions than it answers,” according to Ron Daniel Jr. and Carl Lagoze. Clifford Lynch, Director of the Coalition for Networked Information, doesn’t acknowledge its relevance and questions why a meta-concept should be applied to data. Lynch is credited with saying “[a]ll of it is just data—no Meta-metadata—all data requires mechanisms for discovery, management and access control.” Daniel and Lagoze agree, saying, “there is no essential difference between data and metadata. Metadata is data, no more and no less.”

In spite of these observations, there remains persistence on the part of information professionals to formalize and adopt more, not less, metadata standards and to expand further its definition. Metadata is defined in a summary report provided by the Association for Library Collections and Technical Services Task Force on Metadata as “structured, encoded data that describe characteristics of information-bearing entities to aid in the identification, discovery, assessment, and management of the described entities.” This broad definition could be describing all of the encoding schema discussed throughout this paper, including the paper card catalog record for that, too, is “data about data.” The metadata encoding schemes explored here fall under a narrower definition of metadata and share these characteristics (and weaknesses) in common:

- They provide limited interoperability.
- They attempt to standardize content.
- They are interpretive.
- They are concerned with networked information discovery.
- They are adaptable to a wide range of formats.
- They are accessible to a wide audience of amateur record builders.
- They lack specificity.

The International Press Telecommunications Council (IPTC) was adopting photograph metadata standards as early as 1990 with their development of the Information Interchange Model (IIM), later adopted by Adobe for their image editing software Photoshop. Michael Steidl, author of IPTC's most recent Photo Metadata White Paper (2007), offers practical reasons for using metadata to identify and manage photographs: “Lack of image metadata can delay projects, requiring additional research to confirm caption details and establish rights and permissions.” Steidl claims that without metadata “resources are wasted, opportunities are lost, liability increases and intellectual property rights are eroded.” Steidl drew attention to one of metadata’s less visible roles, encouraging respect for the rights of creators and rights holders and minimizing the risk of an image becoming orphaned (losing its identity). Steidl explains how this protection can be facilitated: “The protection of embedded metadata is supported by laws that are based on the World Intellectual Property Organization (WIPO) Copyright Treaty
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of 1996, which prohibits the removal or alteration of rights management in information.  

DUBLIN CORE METADATA INITIATIVE

One of the better known, more widely used metadata schemes is Dublin Core. Dublin Core was developed and is maintained by the Dublin Core Metadata Initiative (DCMI), which was founded in 1994. A weakness of Dublin Core is that it is intended to provide a standard for data exchange, but because of its simplicity, it does not enforce consistency in its internal data structure. For example, Dublin Core allows the record makers to redefine and extend fields and choose from a number of authorized vocabularies or ignore controlled vocabularies altogether. In 2004, Leif Andresen, Library Advisory Officer, Danish National Library Authority, explored description formats that would support record sharing among archives, museums, and libraries. He concluded, “It is not feasible to use Dublin Core internally in the sectors, as it is far too general and unable to cope with specific needs. The choice of Dublin Core is problematic, because this rather simple format is basically focusing on Web resources.” Again, Daniel and Lagoze concur: “Metadata efforts often fall into the trap of trying to create a universal metadata schema. Such efforts fail to recognize the basic nature of metadata: namely, metadata is far too diverse to fit into one useful taxonomy.”

VRA CORE

At about the same time DCMI was developing Dublin Core, the Visual Resources Association was developing a set of core elements called VRA Core, which focused on the description of “visual cultural works.” The term visual takes on a broad meaning in VRA Core to include artworks, artifacts, paintings, sculpture, architecture, and photographs. VRA Core does a better job of making a distinction between records describing an actual photograph and records describing representations of photographs, a problem sometimes found in Dublin Core records.

The VRA Core element set accomplishes this by providing a categorical organization for the description of a photograph (the “created object”) or a description of the image that documents the photograph (a visual surrogate of the original photograph). The Cleveland Museum of Art uses VRA Core metadata standards to describe their museum photographs. One record, a Lewis Hine photograph titled “Cotton Mill, South Carolina,” presents a view describing the original gelatin-silver print rather than the digital representation shown in the record itself. This is a critical distinction. A surrogate—the concept of substituting one thing for another—sometimes creates a problem in archival description because it is not clear by reading a record what it is that is being substituted.
Categories for the Description of Works of Art

Categories for the Description of Works of Art (CDWA) is another emerging data structure standard. CDWA is a product of the Art Information Task Force funded by the J. Paul Getty Trust, edited by Murtha Baca and Patricia Harpring. It describes a metadata element set consisting of 512 categories and subcategories that can be used to describe or catalog many object types including photographs. To paraphrase Daniel’s and Lagoze’s earlier comment about metadata, CDWA is yet one more data structure, “no more and no less.” Or, as some would say, the good thing about standards is that there are so many to choose from.

International Standard for Bibliographic Data (ISBD)

International Standard for Bibliographic Data (ISBD) provides a standard form of description for the international exchange of bibliographic records. The standard does not define output formats. The International Institute for Social History (IISH), founded in Amsterdam in 1935, holds about 225,192 photographs as of January 2004. About 102,000 photographs have been digitized and entered into the IISH automated catalog using ISBD rules in MARC format records. Information on the other photos in their collection can be accessed on their Web site at the collection level. A MARC record display retrieved from IISH’s image collection presents only a brief record about its subject. For example, in the case of a photograph showing Vincent Auriol and Mrs. Auriol, the description mentions only their names and that they are standing in the library of the Elysée. While the textual detail is quite limited, the record’s role as surrogate for the original photograph is very powerful compared to the relationship between a bibliographic records standing in for a monograph. The IISH record includes a small digital version of the analog photograph. The searcher can, in one sense, see the original photo in its entirety.

General International Standard for Archival Description (ISAD(G))

General International Standard for Archival Description, or ISAD(G), is a structural standard first established in 1994 for use by archives in cataloging collections. ISAD(G) serves as a general guideline for multilevel description and consists of twenty-six elements organized under seven general headings. According to the Second Edition (1999), only six of these elements are considered essential for the effective international exchange of information. The guidelines are general in the sense that they broadly apply to all archival descriptions regardless of their output formats or the way in which ISAD(G) elements are applied, for example, as lists, catalogs, finding aids, etc. The ISAD(G) standards are used by national and international committees who
FIGURE 6 A Full Example Illustrating ISAD(G), The Robert E. Peary Family Collection Illustrating Fonds Level and Series Level Descriptions. Copyright International Council on Archives. Reprinted with permission.

are responsible for developing codes and cataloguing rules. ISAD(G) is not directly used to describe a particular item. Instead, it provides structure and categorizes information as demonstrated in the finding aid shown in Figures 6 and 7, where the Robert E. Peary Family Collection is described on three levels: the fonds level, series level, and file level. It is content standards like Describing Archives: A Content Standard (DACS) that explains what information should be placed in the categories such as Title, Date(s), and Level of description.

The Swedish Fotosekratariat and National Archives of Sweden provides a good example of a national organization that developed a descriptive model based on ISAD(G) for photographs. The Swedish model, known as Dataelementkatalogen, was introduced in 1996 and uses a multilevel structure that supports materials description at any level. Torsten Johansson of the Stockholm City Museum describes the structure of the Dataelementkatalogen as consisting of four levels: fonds, series, file, and item.

ENCODING SCHEMATA: MODS, MADS, METS, AND NISO MIXD

The phrase encoding schemata is generally used in conjunction with standards utilizing XML document formats and serve as standards for encoding structural metadata. MODS (Metadata Object Description Schema) is a
### FIGURE 7


<table>
<thead>
<tr>
<th>Number and name of element of description</th>
<th>Description</th>
<th>Name of element in the language of description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.1 Scope and content</td>
<td>This series consists of black and white photographic prints of family and friends of Robert B. Peary, images taken inside the Peary home, and copies from their travels. Shown are images of Mae Peary and Mrs. Josephine Peary dressed in fur. A picture of a man Peary dressed in fur is also visible on a piano in one of the images showing the apartment, which is shown but the exact address is not given. Some views from trips taken by the Peary's throughout the United States are also included. Some of the images include views of Pikes Peak, Colorado, Cheyenne, Wyoming and Niagara Falls, New York. In addition, there is an undated print of a Bowdoin College Reunion, Class of 1877, Brunswick, Maine.</td>
<td></td>
</tr>
<tr>
<td>3.3.2 System of arrangement</td>
<td>Arranged chronologically by the year the photographs were taken.</td>
<td></td>
</tr>
<tr>
<td>3.4.1 Conditions governing access</td>
<td>All donor-imposed restrictions have been lifted.</td>
<td></td>
</tr>
<tr>
<td>3.4.2 Conditions governing reproduction</td>
<td>Albumen prints may not be copied on electrostatic copying machines or similar equipment.</td>
<td></td>
</tr>
<tr>
<td>3.4.4 Physical characteristics and technical requirements</td>
<td>Many of these prints are very faded and show signs of slight fading.</td>
<td></td>
</tr>
</tbody>
</table>

#### File level

<table>
<thead>
<tr>
<th>3.1.1 Reference code(s)</th>
<th>US DNA NWDNS-XPE-10</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.2 Title</td>
<td>Miscellaneous Family Views Which Include Mae and Robert B. Peary, Jr.</td>
</tr>
<tr>
<td>3.1.3 Date(s)</td>
<td>ca. 1909 (date of creation)</td>
</tr>
<tr>
<td>3.1.4 Level of description</td>
<td>File</td>
</tr>
<tr>
<td>3.1.5 Extent and medium of the unit of description (quantity, bulk, or size)</td>
<td>9 photographic prints</td>
</tr>
</tbody>
</table>

### Bibliographic Element Set

A bibliographic element set much like a MARC record, except it is encoded using XML. MODS can be used to carry certain data elements from an existing MARC 21 record or it can be used to build an original description record. MODS utilizes a much simpler set of elements than what is found in a full MARC format. MADS (Metadata Authority Description Schema) is an XML schema used for an authority element set and serves as a companion to MODS. MODS is to MARC 21 Bibliographic format as MADS is to MARC 21 Authorities format.

METS (Metadata Encoding and Transmission Standard) is a schema for encoding data about digital library objects. METS evolved from an earlier XML document format called MOA2. According to the *METS: Primer and Reference Manual*, the MOA2 DTD “defined a digital object standard for encoding structural, descriptive and administrative metadata along with primary content.” METS built on this model adding the ability to “share, archive, and display digital objects,” including digital audio and video. To encode a digital library object in METS means to record the relationships that exist between pieces of content and the metadata that make up the digital object. The pieces of content could be, for example, the three different digital files typically associated with a digital photograph: the high-resolution archival master copy in TIFF format, the reference copy in JPEG format, and the thumbnail image in GIF format. METS provides a framework for locating these files and their associated metadata.

The last XML schema discussed in this section is NISO MIX (NISO Metadata for Images in XML), which can be used as a stand-alone or as an
extension to METS for describing technical metadata associated with digital still images.\textsuperscript{80} MIX schema provides a format for storing and/or exchanging image data specified in ANSI/NISO Z39.87—Data Dictionary—Technical Metadata for Digital Still Images (2006). The Data Dictionary describes in detail the technical metadata elements, which are designed to enable interoperability between systems and long-term management of digital image collections.\textsuperscript{81}

**Data Content Standards**

Data content standards govern the syntax and form in which information is presented in data structure standards. For example, if Boris Mikhailov is the authorized name in the authority file containing photographers’ names, the data content standard might specify that the last name should be entered first, followed by a comma, and then the photographer’s first name, as in Mikhailov, Boris. Cataloging becomes more complicated when describing photographs because it is a process that engages the archivist in an interpretive process and the quality of description depends on the archivist’s expertise and background in describing images and contextual information.

**ANGLO-AMERICAN CATALOGING RULES AND RDA**

First developed in 1978, the *Anglo-American Cataloging Rules, Version 2* (AACR2) is a content standard, not an encoding or a display standard, and has no connection or influence on how a system stores or communicates information.\textsuperscript{82} It should not be confused with MARC 21, which is an encoding standard and serves a different purpose.

Resource Description and Access (RDA) is a new standard slated for release in 2009 and is intended to replace AACR2.\textsuperscript{83} The original AACR was designed for an environment where paper card catalogs were the dominant access tool to collections. The RDA guidelines, which will be co-published by the American Library Association, the Canadian Library Association, and the Chartered Institute of Library and Information Professionals, will be more flexible and accommodate both digital and analog cataloging systems.\textsuperscript{84} RDA’s primary role is not significantly different from AACR2’s. FRBR, which stands for Functional Requirements for Bibliographic Records, provides the conceptual foundation for RDA.\textsuperscript{85} As its name implies, FRBR is firmly rooted in the bibliographic record model, and one of the major roles of RDA will be to reflect attributes of and relationships between the entities in FRBR as well as in FRAD (Functional Requirements for Authority Data).\textsuperscript{86}

**DESCRIPTING ARCHIVES: A CONTENT STANDARD (DACS)**

*Describing Archives: A Content Standard (DACS)* is a standard designed by and for the archival community. It was deemed an official standard by
the Society of American Archivists in 2004 and replaces an earlier standard known as Archives, Personal Papers, and Manuscripts (APPM). The intention of DACS is to expand on the brief rules presented in AACR2, which concerns archival materials. The Visual Materials Archivists at the University of North Carolina at Chapel Hill Library utilize EAD as their encoding scheme and apply DACS when writing guidelines for their photographic collections. DACS, like its predecessor APPM, is a content standard and describes what to put into the categories that appear in structural standards like ISAD(G).

CATALOGING CULTURAL OBJECTS (CCO)

Closely related to VRA Core is a Visual Resource Association initiative called the Cataloging Cultural Objects Project (CCO), which has gained national recognition as a new project on standardizing the cataloging of visual information. Cataloging Cultural Objects: A Guide to Describing Cultural Works and Their Images is a manual for describing, documenting, and cataloging cultural works and their visual surrogates. Where VRA Core is a data structure standard, CCO is a data content standard that focuses on cultural materials. CCO provides prescriptive guidelines for selecting, ordering, and formatting data used to populate VRA Core catalog records and a subset of CDWA categories.

Data Value Standards and Authority Control

Data value standards govern the terminology that is employed in the given categories or data elements established by data structure standards. Thesauri, controlled vocabularies, and authority files help maintain consistency and standardize the terminology so that information about like materials are brought together on retrieval. A name authority file, for example, the Library of Congress Name Authority File, indicates which personal names among a number of spelling variants and pseudonyms should be used in a description.

Controlled vocabularies are structured lists of terms, usually in the form of thesauri that provide values for MARC-coding and metadata elements. The standard tools used by archivists for controlled vocabulary include Library of Congress Subject Headings (LCSH), Art and Architecture Thesaurus (AAT), and the Thesaurus for Graphic Materials (TGM). The TGM was published in 1995 as a single volume incorporating two separate thesauruses: The Thesaurus for Graphic Materials I: Subject Terms (TGM I) and Thesaurus for Graphic Materials II: Genre and Physical Characteristic Terms (TGM II). As of October 2007, the TGM I and the TGM II were merged into a single vocabulary and can be accessed from the Library of Congress Prints and Photographs home page. The Art & Architecture Thesaurus was originally developed for use as a controlled vocabulary in text-based materials when
making references to objects and images, but it has since evolved to become a tool for describing and cataloging objects and images. ICONCLASS is a subject-specific classification system, a hierarchically ordered collection of definitions of objects, persons, events, and abstract ideas that can be used as subject terms for images. Art historians, researchers, and curators use it to describe, classify, and examine the subject of images represented in various media such as paintings, drawings, and photographs. Graphic Materials: Rules for Describing Original Items and Historical Collections, compiled by Elisabeth Betz Parker in 1982, includes a list of subject headings for arranging and indexing images. It also provides guidelines for cataloging visual materials including photographic prints and negatives. In 2008, the Standards Committee of the Rare Book and Manuscripts Section (RBMS) of the Association of College and Research Libraries (ACRL) agreed to develop a second edition of Graphic Materials as part of the Descriptive Cataloging of Rare Materials suite. It would be designated as DCRM(G) (Descriptive Cataloging of Rare Materials (Graphics)).

Catalogers use various combinations of these and other description and indexing tools for governing content in different encoding standards such as MARC 21. A concern with this approach is that there will be discrepancies between lists, and depending on which list an archivist uses to build a record, the vocabulary list used to build one institution’s catalog may or may not be consistent with another institution’s catalog. The problem of ambiguity and inconsistency in terminology, which prompted archivists to use vocabulary lists in the first place, becomes more complicated as the number of authority lists being consulted increases.

Summarizing Records, Finding Aids, and Description Standards

The information presented previously describes a complex, lattice-like structure that archivists negotiate when building finding aids, catalog records, and other representational artifacts describing photographs. They generally choose a particular set of tools and standards they like or that are required by their integrated library system or digital archives platform and then they stick with them. It’s the most efficient use of time and money. Mixing too many standards together in one organization’s online and database systems could lead to complex mapping problems when migrating to new systems.

Item-level records for the majority of archival photographic materials were not common in early card catalog systems, so consequently there were no item-level records being migrated into first-generation online catalog systems. Other record-keeping systems like Carnegie’s Biography/Business Index (see Figure 5) do point to individual items, but they have never escaped their original encasements—the wooden card catalog. The cards are entombed in an analog system with no traces in the World Wide Web...
or online catalogs. In other cases, catalogs contain only skeletal descriptions of large personal collections. These collections may entail thousands of photographs, handwritten manuscripts, typewritten documents, and assorted realia. Millions, possibly hundreds of millions of individual archival photographs worldwide are stored in archival boxes and files with no record or index pointing to them or informing researchers of their existence.

Because of the enormity of the collections and sheer quantity that is being accessioned daily, it is the usual practice for archivists to catalog their collections at the fonds or series level using a finding aid. A finding aid defines the subject of the collection, its scope, content, and may inventory the collection by assigning titles and classification numbers to the individual manuscripts and photograph albums contained in the collection, but the common practice is not cataloging individual prints and/or negatives. For example, at the time of this writing, the *Collection of the Pittsburgh City Photographer* mentioned earlier contains approximately 150,000 images, and only 2,349 are cataloged at the item level and made available online. This is a case where the University of Pittsburgh’s Archives Service Center follows the principles of provenance and original order describing the photographs as an aggregate in a finding aid and the University’s Digital Research Library offers access to a fraction of the collection online at the item level. More importantly, the data models and description standards that are used by archivists for describing photographs are not semantic Web models, and their purpose is not to make semantic information machine-accessible.

THE NATURE OF KNOWLEDGE REPRESENTATION

While Nerkar’s drunk is looking for his keys under the lamppost, we turn our discussion to exploring other spaces for relevant models of description that may apply to archival photographs. The term *knowledge representation* (KR) may be new to the field of archival description, but it is central to the field of artificial intelligence and so-called expert systems or knowledge base systems. In this section the meaning of knowledge representation is explored in the context of archival description.

Knowledge Representation’s Role as Surrogate

In the early 1990s when Duranti was writing her essay on archival description, three experts in knowledge representation, Randall Davis, Howard Shrobe, and Peter Szolovits were working on a critical review of knowledge representation hoping to clarify what knowledge representation means by defining it in terms of five distinct roles that it plays: (1) at the most fundamental level it is a surrogate, (2) it is a set of ontological commitments,
(3) it is a fragmentary theory of intelligent reasoning, (4) it is a medium for effective computation, and (5) it is a medium of human expression. A close analysis of these roles in the context of what might be considered a new model for archival description falls outside the scope of this article, but it would be useful to look closely at the surrogate role, a concept introduced in 2005 by Richard Pearce-Moses when defining archival description in *A Glossary of Archival and Records Terminology.*

To say that knowledge representation is a *surrogate* is to say it is a substitute for the thing itself. In archival representation, the surrogate is also a substitute for the thing itself. However, there is a critical difference in how these two disciplines view “the thing itself.” Archivists neither attempt to create in the representation a substitute of the document being described nor do they use the surrogate to think or reason about the content of the document. While provenance and original order are meaningful principles, they do not concern themselves with the conceptual landscape of documents or with their meaning. They simply require that the whole of the records created by an individual, family, or organization be kept together, in their original order, and that they are described and preserved as one fonds, series, or collection. Davis and colleagues on the other hand, apply knowledge representation to think and reason about the world rather than take action on it.

Artificial intelligence (AI) raises interesting questions for archivists describing photographs. What do archivists substitute with archival descriptions? What is the finding aid’s intended referent? Is it the photograph itself, the text describing the photograph, or is it the subject(s) represented by the photograph? Davis and colleagues ask, “What attributes of the original does [a surrogate] capture and make explicit, and which does it omit?” Davis and his colleagues admit that the most accurate representation of an object is the object itself and accept the inevitable imperfection of surrogates.

This suggests that archivists should reconsider the models they use for representing photographs with meaningful surrogates. When finding aids state only that “many photographs” are included in a collection, the archivist’s degree of error in accurately representing the photographs is very high.

**Brachman’s and Levesque’s Representer**

Ronald Brachman and Hector Levesque, experts in knowledge representation, describe representation as a “relationship between two domains ... the first is meant to ‘stand for’ or take the place of the second. Usually, the first domain, the representer [sic], is more concrete, immediate, or accessible in some way than the second.” Letting go for a moment of the naming conventions “finding aid” and “catalog card,” this other way of looking at things adopts the concept of two domains, one of which is a representer.
that stands in for another, less accessible domain. Applying Brachman’s and Levesque’s model to the photograph, representation is “a relationship between a textual description of a photographic print that stands in for a less accessible photograph stored in an archives.” It could be argued that in the case of photographs, the representer may also consist of an image or a combination of text and image. In applying Brachman’s and Levesque’s model to another photographic example, Dorothea Lange’s iconic photograph “Migrant Mother” stands for the much more abstract symbolism of the migrant worker during the Great Depression.

The index card pictured in Figure 8 is a representer of a black and white gelatin silver print. This instantiation of a representer consists of both text and image. The image is a contact print, a miniature black and white gelatin silver print glued to the card. The text is a typewritten statement, also glued to the card that includes the photograph’s title, description, photographer’s name, and date. At the top and bottom of the card the cataloger has assigned a record number 11733 and subject heading, “Buildings-Gateway Center.” The indexing system, known as the Pittsburgh Photographic Library Index, provides item-level access to portions of several photograph collections housed in the Pennsylvania Department of the main Carnegie Library in Pittsburgh.102

**FIGURE 8** Paper Index Card in the Current Pittsburgh Photographic Library Index, Pennsylvania Department, Carnegie Library of Pittsburgh, Main (Oakland). Carnegie Library of Pittsburgh. All rights reserved. Unauthorized reproduction or usage prohibited. Reprinted with permission.
In an abstract sense, the subjects discussed in earlier sections of this article related to knowledge representation: knowledge about what constitutes collections of photographs and knowledge about individual photographs. In example after example it was shown that traditional tools used for describing photographs have serious limitations. The archivist’s approach to archival representation and item-level description of photographs is limited because it generally does not describe the photograph in photographic terms, and in the case of finding aids, it is common to exclude information about photographs at the item level. Archivists have used generalized architectures for structuring and encoding records that describe photographs, for example Dublin Core, EAD, and MARC 21, and then applied a set of in-house rules or a set of broader standards such as AACR2 or DACS to explain what information goes into a chosen data structure.

For generations, the representers archivists used to stand in for photographs were natural language descriptions written in paper finding aids and card catalogs like those pictured in Figures 3 and 4. When display mechanisms and data structures were digitized and the analog records of archives were migrated to online catalogs and the Web, archivists ended up imitating and re-creating what are really nothing more than digital versions of the failed paper card catalogs and paper finding aids, which are not concerned with semantics and are syntactically inconsistent. The online records of the Cleveland Museum of Art discussed earlier look eerily similar to the paper index card shown in Figure 8.

Most important, the information contained in the representers is expressed in natural language; that is, the language humans use for writing and speaking. The information is not being formalized in a language that the machine it is stored on understands beyond what it sees as a series of squiggly lines. In effect, the first machine is prevented from sharing its knowledge with any other machine. Natural language descriptions will be the biggest inhibitor preventing current archival description models from being “meaningful” and sharable on the semantic Web. In the record illustrated in Figure 6, a machine can read the number “1960” but doesn’t know it represents a date or what a date is; a machine can read the string of ASCII characters “Robert E. Peary Family” but doesn’t know what a “Robert E. Peary Family” is or what it means to be Robert E. Peary.

A fundamental question to ask at the beginning of this discussion on the nature of representation and the photograph is this: Do archivists who are engaged in describing and cataloging photographs need a more formalized representation for photographs, or do existing architectures provide enough foundation and structure for the next generation of knowledge sharing? Tim Berners-Lee, the founder of the World Wide Web, envisions the next generation of the Web, Web 3.0, as being a semantic Web—a Web where machines not only read but understands what they read. The description models and standards explored in this paper weren’t designed for communicating
information about photographs in a semantic Web environment. Two con-
cepts, ontology and logic, are introduced in the last sections of this article
as necessary formalisms for making archival photographs meaningful and
accessible in semantic Web 3.0.

THE SEMANTIC ARCHIVE MODEL

One possible approach for exploring Web 3.0 archival description begins
with redefining the meaning of archival description. The following definition
is proposed as a starting point: Archival description is a formalization that
represents an entity in a way that is accessible to and can be processed
effectively by both humans and machines.

The Semantic Archive Environment

The semantic archive environment in an institutional setting is illustrated
in Figure 9. The semantic archive does not operate in a closed environ-
ment. The archivist is not a gatekeeper. The semantic archive exists in
an environment populated by external stakeholders. The semantic archive
stores knowledge about photographs and it stores images of archival prints.
The archivist and community of users are external stakeholders. They share
knowledge with each other about photographs. The archivist and the com-
community of users search for photographs and they ask the machine questions
about photographs. The machine responds with answers to questions, some-
times drawing new inferences from existing knowledge, and it directs users
to photographs that are relevant to their queries. Machines communicate
with one another, listen to one another’s questions, and share their knowl-
dge. As the world changes, the knowledge base is brought up to date. The
institutional semantic model still houses analog photographs in an archives,
although the archives is not a functional component of the semantic archives.

![Semantic Archive Environment](image)

**FIGURE 9** The Institutional Semantic Archive Environment.
per se. As shown in Figure 10, the archives exist outside of the functional model.

The Semantic Archive Functional Model takes a look at what is inside the “black box” shown in the earlier semantic archive environment (Figure 9). The first functional component is the scribe. The scribe describes photographs at the ontological level of knowledge representation and describes and formalizes the photograph’s meaning, including provenance, context, function, along with descriptive information such as the photographer’s name, date, place taken, what it is of and about.

The second component is the knowledge base. This is the component where formalisms describing photographs are stored. Information is not segmented and tagged, categorized, and indexed as being a title, a creator, a scope note, a subject, or a component of provenance and original order. The knowledge base is simply populated with semantic annotations of photographs, and the semantic annotations include all of these facts in an expressive and universal representational language.  

The image silo is the third functional component. The image silo is responsible for creating archival-quality digital copies of the original photographs. The image silo manages the long-term storage and preservation of digital images.

The fourth and last functional component is access. Access provides the user community with a system for seeing what is available and for locating photographic prints in the analog and digital archives. Access provides users with information about photographs and aids in locating and retrieving photographs relevant to their searches. Users can ask access questions about photographs and share information they have relating to photographs found in the semantic archive.

**DEFINING ONTOLOGY**

It is not likely that everyone will accept a single definition of ontology. Over time and in different disciplines its meaning has changed, but it is necessary to have a clear understanding of ontology to understand the semantic
archive model. Ontology originated in the field of philosophy as a branch of
metaphysics concerned with the systematic account of existence or being.\textsuperscript{105} Ontology subsequently found its way into the field of AI, most notably in the
writings and research of Thomas Gruber. Gruber’s often-cited definition of
ontology describes it as an “explicit specification of a conceptualization.”\textsuperscript{106}

Gruber elaborates on this further, defining conceptualization as “an abstract,
simplified view of the world that we wish to represent for some
purpose.” In the context of knowledge representation, to specify means to
formally describe a domain of discourse in terms of concepts and relation-
ships. For example, if our domain of discourse is libraries, concepts or “class
terms” may include staff members, patrons, books, and journals. These are
all common nouns that are representative of objects belonging to sets or
classes, including the class of all staff members, the class of all patrons, the
class of all books, and the class of all journals.

Relationships are typically built by hierarchically arranging these various
concepts, or classes of objects. All librarians for example, are members of
the class staff members. Reference librarians are a subclass of librarians.
All monographs are books. Trade journals and newspapers are subclasses of
periodicals. Relationships may exist between classes, for example, between
the class consisting of librarians and the class consisting of books. Librarians
catalog books and librarians select books. Some assertions made about
this domain of discourse may involve complex relationships among many
objects. The assertion that librarians withdraw books from libraries based
on the Crew Guidelines for weeding collections establishes relationships be-
tween librarians and books, guidelines and weeding, books and collections,
collections and libraries, and weeding and collections. Relationships may
exist between patrons and books as well. Patrons read books and patrons
checkout and request books. And, finally, relationships may also exist be-
tween librarians and patrons. For example, patrons ask librarians questions
and librarians read stories to children.

Another defining characteristic of ontology in the context of AI is the use
of formal constraints on how vocabulary is used. For example, a librarian’s
age is constrained to a value type number with a cardinality of one. Sanford
Berman is an instance of the class “librarian” and can have only one age and
age must be expressed using integers.

Ontologies in the context of the Web, writes Kim Jung-Min and
colleagues, enable sharing and reuse of information among people and
machines.\textsuperscript{107} This leads to sharing different terms that represent the same
object. Again, applying this to our sample domain of interest “libraries,” aca-
demic library A may call journals serials while public library B calls journals
periodicals. These differences can be overcome by mapping terms to specific
ontologies or by defining mappings of topics between ontologies.\textsuperscript{108}

Photographs and their descriptions involve a universe of discourse that
is both interpretative and factual. Looking at a photograph and describing
what it means could be as simple as listing the names of elements recognized in a picture or as complex as interpreting abstract symbolisms represented by those elements. Viewers consciously and subconsciously involve themselves in processes that create relationships between abstract ideas and concrete objects; viewers identify concepts and properties, bringing to the interpretive process all of their past experiences. Graham Clarke, one of Britain’s most popular authors and illustrators said, “Whenever we look at a photograph image we engage in a series of complex readings which relate as much to the expectations and assumptions that we bring to the image as to the photographic subject itself.”

There are characteristics shared in common among all photographs while other characteristics belong only to one photograph. The ontology of the photograph is a formal conceptualization of this world and all it entails; the common elements that join together all of its parts and the unique properties that define and characterize each photograph’s individuality.

At this point in the discussion readers may ask, “How can one archivist build an ontology that conceptualizes a domain of interest so large as to include the photograph and all possible subjects a photographic image may entail?” It requires a stretch of the imagination, but one could think of an ontology of photography as being an authority file or controlled vocabulary in terms of taxonomy, something like the Library of Congress Subject Headings or the Getty Art & Architecture Thesaurus, but it’s dangerous to make such comparisons because an ontology is much more. The taxonomy of terms used to describe photographs might provide a simple backbone for designing an ontology, but an ontology is also a conceptualization expressed in a formal language. Referring back to the example that used libraries as a universe of discourse, an ontology expresses relationships between entities. The methodology for building an ontology, as Adam Pease describes it, “is a theoretically and philosophically informed approach ... both top-down and bottom-up (as well as middle-out.)”

There is not yet in existence an ontology of the photograph, and it is a formidable process to build one, but there are many other general-purpose ontologies, upper ontologies, midlevel ontologies, and domain ontologies already in existence.

LEVELS OF REPRESENTATION

Knowledge representation and levels of representation are now introduced and briefly discussed in an attempt to build a foundation for understanding the relationship between ontological knowledge and natural language understanding. In order for machines to understand the archival descriptions of photographs, archivists must understand the semantics of the natural language along with the relationship between the language and the world.

A cataloger who describes a photograph using MARC 21 and AACR2 views their representations on two levels: (1) the level of the physical
object—the photograph housed in its file folder or protective sleeve, which is in turn stored in an archival box or filing cabinet, and (2) the representational artifact that stands in for the actual photograph. The next section introduces a different view of levels of representation.

Guarino’s Levels of Representation

John McCarthy and Patrick Hayes made early efforts at formalizing knowledge and making explicit representations of the world. In 1969, McCarthy and Hayes said, “A computer program capable of acting intelligently in the world must have a general representation of the world in terms of which its inputs are interpreted. Designing such a program requires commitments about what knowledge is and how it is obtained.”\(^{111}\) John F. Sowa described two distinct levels of representation that McCarthy and Hayes called epistemological and heuristic: “The epistemological level is solely devoted to knowledge about objects and processes in the application domain ... the heuristic level introduces data structures for representing the objects and programs for simulating the processes.”\(^{112}\)

Further refinement of these levels was made in 1979 when Ron Brachman divided knowledge representation into the following five levels: (1) implementation level, (2) logical level, (3) epistemological level, (4) conceptual level, and (5) linguistic level.\(^{113}\) Nicola Guarino looked at philosophical concerns and in 1995 introduced an ontological level, which falls between the epistemological and conceptual levels.\(^{114}\) The distinctions introduced by Brachman along with Guarino’s ontological level are illustrated in Figure 11. The first three levels (logical, epistemological, and ontological) are explored in more detail to illustrate three levels of representation that would be used in a semantic archive model.

**Logical Level**

To begin thinking more in terms of photography, the phrase *some calotype print* is used in the following examples of formalizations at the logical and epistemological levels. The most basic level of representation is the level of

<table>
<thead>
<tr>
<th>Level</th>
<th>Primitives</th>
<th>Interpretation</th>
<th>Main feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical</td>
<td>Predicates, functions</td>
<td>Arbitrary</td>
<td>Formalization</td>
</tr>
<tr>
<td>Epistemological</td>
<td>Structuring relations</td>
<td>Arbitrary</td>
<td>Structure</td>
</tr>
<tr>
<td><strong>Ontological</strong></td>
<td><strong>Ontological relations</strong></td>
<td><strong>Constrained</strong></td>
<td><strong>Meaning</strong></td>
</tr>
<tr>
<td>Conceptual</td>
<td>Conceptual relations</td>
<td>Subjective</td>
<td>Conceptualization</td>
</tr>
<tr>
<td>Linguistic</td>
<td>Linguistic terms</td>
<td>Subjective</td>
<td>Language dependency</td>
</tr>
</tbody>
</table>

**FIGURE 11** Guarino’s Levels of Formalizing Representations.\(^{115}\)
first order logic where, as Guarino described it, “primitives are predicates and functions, which have given a formal semantics in terms of relations among objects of a domain.” The logical relationships are presented in Figure 12.

This is the level of formalization that is understood as the most “basic” level in the sense of being the most neutral. Guarino described first-order logic as being “notoriously neutral with respect to ontological choices. This is one of its strengths.” For example, the fact that there is some calotype print could be represented in first-order logic as two unary predicates:

$$\exists x \text{ print}(x) \land \text{calotype}(x)$$

Guarino refers to interpretations like this as being “totally arbitrary,” which is to say that at this basic level there is no ontological difference (or any other kind of difference) between the terms print and calotype.

**EPISTEMOLOGICAL LEVEL**

The epistemological level is the next level of representation. At this level certain decisions are made about the concepts and their interrelationships as conceptual units. More structure is being imposed on the information being represented at this level. It is here that the decision is made that a relationship exists between “print” and “calotype” and that this relationship exists within a hierarchical framework. The term calotype represents a class of objects, and print represents a super class. There is a relationship between “calotype” and its corresponding super class indicated by a binary “typeOf” relation. This can be expressed in predicate logic as:
∃x calotype(x) ∧ typeOf(x,print)

This formula can be read as: There exists an x such that x is a calotype and x type of print.

**ONTLOGICAL LEVEL**

At the epistemological level of representation there was no methodological reason for choosing to treat “calotype” as an object and to treat it as a subclass of “print.” There was nothing preventing the knowledge worker from making the reverse true, that “print” is a subclass of “calotype,” or making “print” a concept and “calotypeness” a property where “calotype” is the value of a binary “hasQuality” relation. The important point here is that depending on the decisions made at the epistemological level, it may be easier or harder to setup certain inferences later on.

It is at the ontological level where modeling decisions are clarified, where specifications of what is meant by “print” and “calotype” are made explicit. The ontological level is the level of meaning. Decisions made at this level are no longer arbitrary because ontological choices reflect the real world where prints and calotypes are concrete objects with physical qualities. Guarino states that ontological commitments can be made in two ways, “either by suitably restricting the semantics of the primitives, or by introducing meaning postulates expressed in the language itself.”

Ontologies provide a basis for interoperability and information sharing among different domains of knowledge in much the same way that authority lists and controlled vocabularies enable sharing of bibliographic data among disparate library systems. Ontologies differ, though, in that they are not restricted to describing things. Ontologies are equally concerned with the relationships that exist between entities, states of existence, and temporal qualities.

**CONCLUSION**

In the literature review it was established that there is a long-standing tradition in the archival profession that the arrangement of archival records is based on the precepts of provenance and original order, and this arrangement provides the basis for description, a process that continues throughout the life of the record. It was determined that these precepts of arrangement and description also apply to the photograph, whether accessioning a single photograph or a collection of photographs and negatives.

A number of problems surface in the current record-keeping models used by archivists when envisioning their application in a semantic-based Web 3.0 environment where machines not only read but understand
meaning. This is not to say card index systems like the Pittsburgh Photographic Library Index are not functional. They function within a prescribed set of rules that work well for the individual researcher who is standing at the card index thumbing through broad subject categories. When the researcher finds an index card relevant to his or her topic of interest, the searcher asks the archivist for assistance in retrieving a photograph stored in the archives. The same holds true for collection- and item-level descriptions in online catalogs. Within their prescribed rules they may serve a useful purpose under some circumstances.

The domain of interest investigated in this article focused on the world of archival photographs and photographic archives. The main problem is one of representation and choosing an artificial intelligence language to describe this world, a world that exists at the junction where ontology, photography, and archival science collide. The research that proceeds from this point forward requires choosing an already existing and functioning artificial intelligence architecture, one that has upper- and midlevel ontologies in place. To this researcher’s knowledge there is no existing architecture that includes an ontology of the photograph, so this is where the work begins. How does one approach building an ontology of the photograph? John F. Sowa described how philosopher Willard Van Orman Quine expressed the fundamental question of ontology in just three words: “What is there?” And the answer was given in one word: “Everything.” So the first challenge is to begin modeling a world that is smaller than everything but big enough to explain what the photograph means.

Choosing an artificial intelligence architecture in which to carry out this task is the next challenge. It is a little something like choosing which of the traditional data content, structure, and value standards one should use for building item level records and finding aids. In the case of artificial intelligence, however, the main concern is choosing a representation language that offers the right balance between expressiveness and reasoning. Levesque and Brachman offer valuable advice regarding this balance by explaining there is a tradeoff between the degree of expressiveness offered by a representational language and the ability to reason with that language. They suggest that as a representational language’s expressive power increases, one’s ability to handle that system and effectively reason with it decreases. Two likely candidates that deserve serious consideration for an ontology of photography are SUMO, which is expressed in a language called SUO-KIF (standard upper ontology–knowledge interchange format) and Scone, which uses Common Lisp to build its knowledge base.

To begin exploring this model further, a small experimental knowledge base should be built and its effectiveness tested by measuring whether it can answer a set of predetermined competency questions. These questions should inquire about the nature of the photograph in the context of a photographic archive, a world where the photograph’s meaning is not only derived
from its physical nature and image content but from its provenance, its location within an institution, and its relationship to and function within a larger record set.

NOTES

2. An example is Gilda Williams, a critic and curator of contemporary art and photography and former managing editor of Flash Art International. For an example of her work, see Gilda Williams, Boris Mikhailov (New York: Phaidon, 2001).
5. For one of the most historically significant commentaries on photography by a photographer, see the description of “View of the Boulevards at Paris” in William Henry Fox Talbot, Pencil of Nature (New York: Da Capo Press, 1969).
14. Muller, Feith, and Fruin, Manual for the Arrangement and Description of Archives, 100.
22. Miller, Arranging and Describing Archives and Manuscripts, 7.
23. Miller, Arranging and Describing Archives and Manuscripts, 25.


28. Wendy M. Duff and Verne Harris, “Stories and Names: Archival Description as Narrating Records and Constructing Meanings,” *Archival Science* 2 (2002), 264. The context in which this statement is being made is historical. The authors are describing some key assumptions made by archivists rooted in the “traditional streams” of archival description. They later outline new questions raised by postmodernists; for example, “Do archivists participate actively in the construction of a record’s meanings and its significances?” (p. 265).


35. Ibid., 142.

36. The MARC for Archival Visual Materials: A Compendium of Practice sets out the rules for creating individual records for photographs. See Maryly Snow, “Visual Depictions and the Use of MARC: A View from the Trenches of Slide Librarianship,” in *Beyond the Book: Extending MARC for Subject Access*, eds. Toni Petersen and Pat Molholt (Boston, MA: G. K. Hall, 1990). Snow discusses the advantages of shared cataloging. She explains that the *Art and Architecture Thesaurus* (AAT) is approved for use in entering controlled subject vocabulary in MARC’s 654 field. By entering item level records in national bibliographic utilities such as OCLC, librarians are able to view other libraries’ records and borrow terms they see are appropriate for their collections or, if authorized, can add terms to each other’s records. Snow made the observation that where an image is located in a book there is also related textual information. She suggested that creating links for an image item record to its source book would create a de facto subject index to specific persons and places.


39. Ibid.


43. Ibid.


46. This terminology is borrowed from a framework proposed by David Beaman for classifying standards, which was presented at the first meeting of the Working Group on Standards for Archival Description (WGSAD) who in turn developed a three-dimensional matrix that viewed standards in terms of strength of standard, developer of standard, and level of description. The matrix presents four levels of description; however, this paper is concerned with only three, leaving out


49. Klijn and de Lusenet, SEPIADES, 14.


51. Ibid.


58. Ibid., 8.

59. Ibid.

60. Another rights metadata solution is copyrightMD version 0.9 developed by the California Digital Library (CDL). The copyrightMD schema is designed to be incorporated with other XML schemas for descriptive and structural metadata (e.g., CDWA Lite and MARC XML). See http://www.cdlib.org/inside/projects/rights/schema/. See also Karen Coyle, “Descriptive Metadata for Copyright Status,” First Monday 10, no. 10 (October 2005). Available at http://firstmonday.org/hbin/cgiwrap/bin/ojs/index.php/fm/article/view/1282/1202.


64. The Data Standard Committee of the U.S.-based Visual Resources Association developed VRA Core elements in 1996. The standards are currently on Version 4.0, released in 2007 and can be accessed at http://www.vraweb.org/organization/committees/datastandards/.

65. Worthington Memory is a project of Worthington Libraries and Worthington Historical Society in Ohio that utilizes Dublin Core as their encoding scheme. The Dublin Core element used for describing the photograph’s format describes a digital image file, not the original photograph for which the online records serves as surrogate. Available online http://www.worthingtonmemory.org/ (accessed April 20, 2009).


72. International Council on Archives, ISAD(G), 9.

73. Ibid., 7.

74. Ibid., Appendix B, n.p.

75. Klijn and de Lusenet, SEPIADES, 10.

76. Ibid., 11.


86. For a more detailed explanation of the FRBR model and the impact of FRBR on cataloging standards, see Pat Riva, “Introducing the Functional Requirements for Bibliographic Records and Related IFLA Developments,” Bulletin of the American Society for Information Science and Technology 33, no. 6 (August/September 2007): 7–11.


92. The Thesaurus for Graphic Materials can be accessed online at http://www.loc.gov/rr/print/tgm2/ (accessed September 24, 2008).


96. The concepts of knowledge representation presented in this section could be extended to any number of document forms, but the focus of this paper is on the archival photograph. The reason for this focus becomes more apparent when the discussion shifts to ontology. Reasoning about knowledge associated with the photograph (physical entity) and the image portrayed on its surface raises markedly different ontological questions than does say reasoning about an audio file or textual document.


100. Ibid., 18.


102. This card indexing system could be considered a precursor to the modern online photo archives—for example, the British Columbia Archives, whose records include “thumbnail” images and text. British Columbia Archives, Royal BC Museum, “Visual Records: Overview,” available at http://www.bcarchives.gov.bc.ca/sn-278EA8D/visual/visual.htm (accessed November 22, 2008). The British Columbia Archives consists of several collections, including a visual records index that contains over 179,000 textual descriptions and over 84,000 images online.


104. One possible specification language for representing formal ontologies in the semantic Web is Knowledge Interchange Format (KIF). KIF is an expressive, declarative first-order predicate logic language. A variant of KIF is used for describing the largest public ontology SUMO (Standard Upper Merged Ontology). KIF, along with Ontolingua Frame Ontology, is the representation language used in Stanford University’s Ontolingua System. See http://www.ontologyportal.org/ and http://www.ksl.stanford.edu/software/ontolingua/.


106. Ibid.


116. Ibid.

117. Ibid., 631.

118. In first-order logic, unspecified objects are represented by variables, in this example “x.” If reference was being made to a specific calotype print named “Washington,” then it could have been formalized as: print(Washington) ∧ calotype(Washington).


120. Ibid., 633.


123. Astute readers may wonder why the author has not suggested, for example, the popular ontology editor Protége and OWL ontology language in the closing paragraphs of this paper. For one reason, this paper is at its close and the topics of languages and editors, as well as reasoners and ontologies, deserve a separate treatment in another, future paper. It’s also worthwhile bringing to the forefront two less well known architectures (possibly due to their complexity and absence of user friendly help guides) that are quite powerful for very different reasons. What is most important is to begin hunting for answers to questions about effective ways of representing the meaning of photographs in a Semantic Web environment by letting go of card catalogs and finding aids along with their myriad standards and to begin exploring new approaches.