Teaching archival technology online

Richard Pearce-Moses*

ABSTRACT

To thrive in the digital era, archivists need the knowledge and skills to work with electronic records. Graduate students need courses that address those needs, and many practitioners want courses as continued professional education. The limited number of schools offering advanced courses in archives and technology is a geographic barrier to access. In response, Clayton State University developed a fully online Master of Archival Studies Program. This program's curriculum and learning outcomes build on traditional archival practice and knowledge by incorporating content that emphasizes digital archives and technology. Finally, the program has developed pedagogical methods and techniques to engage students in a rich, online environment and a general rubric to assess proficiency. The description of the program's approach may be useful for other programs considering how to incorporate technology skills and to adapt online education into traditional, face-to-face programs, both in the United States and other countries.

Keywords Archival education • Online education • Digital archives • Pedagogy

In order to thrive in the digital era, archivists need the knowledge and skills to work with electronic records. Tangible formats will never disappear, but at some point the majority of records that archives acquire will be virtual.[1] For example, digital photography has almost entirely replaced traditional techniques. David Hockney (2011) observed, "Chemical photography is now ended. It lasted 160 years. Nobody thought chemical photography would end. Nobody predicts that." Hockney's comment is a bit of a hyperbole. Chemical photography is not entirely dead; a few photographers continue to make photographs using archaic processes such daguerreotypes and ambrotypes. Similarly, tangible record formats will never be entirely dead. However, as the world moves more and more to digital information, electronic records will inevitably become the predominant format in archives.

* Clayton State University
E-mail: rpearcemoses@clayton.edu

[1] Some will object to the use of 'tangible' to characterize records that have been called traditional, analog, paper, and other terms that I find sufficiently inadequate or inaccurate. Electronic records have physical qualities that are ultimately tied to the material world, but I would argue one cannot touch electronic records directly. One can touch the media on which the records are stored, but one "handles" these virtual records through some mediating technology. For the sake of simplicity, in this paper I distinguish tangible formats, such a manuscripts, print and film photographs, and similar formats that are generally eye readable and "born analog," from virtual formats, which require mechanical intervention and are usually "born digital." Some formats, such as phonograph records, may be born analog, but even though they are not digital may still be considered virtual records because they require technology to be accessible.

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Before the profession reaches that tipping point, all archivists – with the possible exception of those specializing in historical records in tangible formats – must be digital archivists. Otherwise, contemporary, digital records may become the purview of other professions more closely associated with technology. If archivists fail to respond to the challenges of digital era, they may find themselves limited to working with records created in a specific period – much like the 160 years that chemical photography thrived.[2]

James G. Neal (2006), Vice President for Information Services and University Librarian at Columbia University observed

> Historically, the shared graduate educational experience has provided a standard preparation and socialization into the library profession. [Integrating new professional groups 'raised' in other environments brings] to the academic library a 'feral' set of values, outlooks, styles, and expectations. We are only beginning to see the impact of these staffing strategies in such areas as employee relations, training, management, and leadership.

As evidence of this shift, employees in many organizations may direct questions about managing and accessing electronic records to a CIO rather than to a records manager or archivist. While other professions may have expert technical skills, they may not appreciate the long-term value of the records, much less share archivists' values for authenticity, trustworthiness, and cultural and corporate memory.

To be prepared to enter the job market, students in graduate programs need courses that give them skills to be digital archivists. (Kim, Warga, and Moen 2013). As well, many practicing archivists need and want that same education as part of their continued professional development. Unfortunately, these students and practitioners have limited access to formal education programs. Schools in only seventeen states offer degrees or certificates in archives, resulting in a geographic barrier to access.[3] Both prospective students and practitioners may have families and good jobs that make it impractical to move to another city, state, or even a different country to attend classes.

Responding to this need, Clayton State University developed a fully online Master of Archival Studies Program that prepares students to work as digital archivists. Clayton's online program complements traditional programs offering face-to-face classes. Each

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[2] This paper presumes that archival education must go well beyond traditional archival practice that focuses on tangible records. Rather, it must address the impact of technology, not because virtual records and digital archives represent the future but because they are the present. I have offered my thoughts on this paradigm shift in "Janus in Cyberspace: Archives on the Threshold of the Digital Era" (Pearce-Moses 2007) and "Flatland to Virtual: Transcendence and the Digital Dimension" (Pearce-Moses 2008).

[3] The "Directory of Archival Education" (Society of American Archivists 2015) lists 27 on-campus certificate, graduate certificate, and master's programs in seventeen states in the United States and two provinces in Canada, and two online programs, including Clayton State. Not all of those programs include in-depth courses in digital archives.

approach has its own affordances. The question is not which is better, but how to ensure that students get a good education, regardless of approach.

Students take courses in all the core domains, including theoretical foundations of appraisal and acquisition; arrangement and description; reference and access; preservation; outreach and advocacy; management; and professional, ethical, and legal responsibilities. They learn to work with tangible formats in traditional positions. However, the program emphasizes digital archives. Students also take technology courses so that they understand the context of digital information systems and they have practical skills to work with electronic records.

In each fifteen-week course, students attend weekly, live class meetings using web-based video conferencing.[4] Classes last two hours, and are designed to replicate – as closely as possible – a face-to-face experience. Students and the instructor see and hear each other. They ask questions or make comments in real time on the audio channel by raising their hand to get the floor or by posting a note to a chat box. The interactions are similar to a traditional class, including lectures, group discussions, and presentations. Outside the online class, students explore readings and collaborate on projects using asynchronous discussion boards that are part of a learning management system.[5] Students can work as small groups using the same channels. Students can schedule office hours for individual assistance using video conference, email, or phone.

The program includes individuals with little or no background in archives who want to work in the field. The program also welcomes practitioners, ranging from paraprofessionals, who want to advance their career by earning the degree, to individuals with significant experience, who want to take specific courses focused on technology.[6] A few practitioners have taken courses as a way to structure the analysis of some aspect of their current job and to review policies, procedures, and policies based on a systematic review of a particular domain. For example, an archivist might take the appraisal course to structure a review of an existing collecting policy or to develop a new policy.

The program's learning outcomes relate to technical aspects of the core archival domains, as well as the technical knowledge and skills necessary to be a successful digital archivist. Those outcomes fall into three categories: the digital information ecosystem, technical infrastructure, and technical skills. Clayton State has also developed a variety of pedagogical approaches to engage students in an online environment. Those approaches fall into two broad categories, presentation of theory and concepts through lecture, readings, and class

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[4] Clayton State used WebEx through the spring of 2015, but moved to Blackboard Collaborate in the summer of 2015.

[5] When the program began, the university used Blackboard, but has since migrated to Desire to Learn (D2L).

[6] The program seeks to meet students' needs, with respect for their experience. For example, some students are practicing archivists and have a master's in public history or library science; two are Certified Archivists. To fulfill required courses in areas they are thoroughly familiar with, they worked with a professor to explore the topic in depth and write papers for publication. In other courses, they adapted the assignments to their jobs; for example, they developed a digital preservation and preservation policies specific to their institution.

discussion, followed by application and integration through assignments that provide students with a deeper understanding through practical application and integration of that knowledge. Finally, the program has developed a general rubric and tools to assess students' mastery of the content.

Professional Knowledge and Learning Outcomes

Thriving in the digital era requires more than the knowledge and skills to work with electronic records – that is mere survival. Rather, to be truly successful, to prosper and flourish, archivists must have the ability to be self-reliant and do things on their own without being dependent on others with technical skills. It means knowing enough about the tools to conceptualize creative technical solutions to archival problems. It means having insights and contributions to be fully engaged with others throughout the records lifecycle. They must be able to work with the people generating and using the records, with the technologists who have custody of the records in their systems, along with legal counsel who rely on those records, and – ultimately – with the patrons who will use the records into the future.

When developing the curriculum, faculty began with the Society of American Archivists' "Guidelines for a Graduate Program in Archival Studies" (2011) and the Academy of Certified Archivists' *Handbook for Archival Certification* (2012). Although they use different headings for outcomes, the categories largely overlap. The resulting curriculum includes required courses in each of those core domains, including general knowledge of records and archives; selection, appraisal, and acquisition; arrangement and description; reference and access; preservation; outreach and advocacy; management; and professional, legal, and ethical responsibilities. The program also includes courses in records management and digital preservation.

In addition to courses in the core domains, students take three courses that focus on technical knowledge and skills. While the Society's Guidelines and the Academy's Handbook served as the basis for program and course outcomes relating to the discipline, developing appropriate learning outcomes for technology courses was a significant challenge. The field of digital curation and preservation has evolved significantly over the past few decades, but is far from mature.[7] Moreover, digital archivists need more than a single set of technical skills. Individuals processing collections will likely need different skills from others working in preservation. Those working with different formats (for example, email, GIS systems, collections of unstructured records on a hard drive, web content) will need format-specific

[7] As evidence, I believe the definition of these terms remain in flux, with 'digital curation' and 'digital preservation' often used interchangeably or with significant overlap. The comment is not meant to be disparaging or to discount invaluable work by many individuals I greatly admire. Paraphrasing an opening question by Margaret Adams at the *New Skills* colloquium, "What's new? The National Archives Center for Electronic Records has been doing this work for a long time." Much has been written and published on the subject. Still, I believe the field is only now moving out of a formative stage, with much of that work represented the discipline's infancy, helping archivists fully understand the problem enough to begin to propose practical solutions even as the rapid changes in technology make those solutions a moving target. Again in my opinion, the publication of the OAIS Reference Model marks the beginning of adolescence, as professional practice generally has accepted this model. Still, the model is high level and can be implemented in a variety of ways.

tools. Until well-established, time-tested practices are identified, teaching technology to support digital curation and preservation necessarily remains in a formative phase.[8] As a result, the overarching outcome for technology courses is to give students a foundation to continue their education on their own, to be able to learn skills specific to the job at hand. Patricia Galloway, who teaches "nascent digital archivists" in the School of Information at the University of Texas at Austin argues, "as the digital infrastructure evolves . . . students have to learn to learn, and that's the bottom line."[9]

The faculty took cues for the technology-centered learning outcomes from several sources.[10] Richard Pearce-Moses, the program director, was actively involved in the development of the Digital Information Management (DigIn) certificate program, led by Bruce Fulton and later Peter Botticelli, at the School of Information Resources and Library Science at the University of Arizona, and brought with him invaluable insights from his colleagues there.[11] The colloquium *New Skills for a Digital Era* (Pearce-Moses and Davis 2008) identified skills based on case studies presented by archivists and records managers who had worked with electronic records. The DigCCurr conferences explored the question in greater depth.[12] Christopher A. (Cal) Lee's "A Matrix of Digital Curation Knowledge and Competencies" (2009a) and "Curation Junction, What's your Function?" (2009b) summarizes much of what was presented at those meetings. Shortly after Clayton's program began, the Library of Congress (2010) started its Digital Preservation Outreach and Education program, which offers training based on a needs assessment conducted in 2010. The question of skills digital archivists need remains current, with Jackie Dooley (2014) recently posting her thoughts on the blog *Hanging Together*. Faculty continually incorporated results of further investigation into the program's learning outcomes as part of an on-going quality review.

The range of information that digital archivists might potentially need to know is enormous and well beyond what can be covered in even a 45-hour program graduate program. As those working on the DigIn program discovered, one of the greatest challenges is one of "simple editing; that is, deciding what content to exclude from our courses" (Botticelli et al. 2011,

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[8] "Teaching digital curation means engaging with an immature discipline characterized by fluid professional boundaries and uncertainty in the development of vital infrastructure. The lack of established standards and best practices means that we cannot teach digital curation with the same level of specificity we have taught other subjects" (Botticelli et al. 2011, 149).

[9] Email to Archives and Archivists mailing list, 31 March 2014.

[10] A group of faculty and advisors assisting in the initial process included Lori Ashley, David Carmicheal, Wesley Chenault, Robin Dale, Cheryl Oestreicher, Sarah Quigley, Tina Seetoo, and Christine Wiseman. Others who have contributed significantly include Christa Hardy, Bradley Westbrook, and Seth Shaw. Shaw is currently on faculty and actively refining and developing courses.

[11] As noted above in Botticelli et al., Pearce-Moses previously worked on research projects to build tools to use technology to support the work of digital curation, and his experience strongly influenced decisions regarding the technical knowledge and practical tools students needed to study, including the ECHO Depository Project at the University of Illinois, Urbana-Champaign, funded by the Library of Congress' National Digital Information Infrastructure Preservation Program (see http://www.ndiipp.illinois.edu/) and the Persistent Digital Archives and Library Systems (PeDALS) project, also funded by NDIIPP (see http://www.pedalspreservation.org/). See also Bruce Fulton, Peter Botticelli, and Jana Bradly (2011). This article is particularly useful for its description of the courses in the DigIn program.

[12] DigCCurr I (2006-2009) and DigCCurr II (2008-2012) were led in large part by Helen Tibbo and Christopher A. Lee (see http://www.ils.unc.edu/digccurr/).

148). With the founding of the program in 2010, Clayton's faculty and advisors also faced this problem. Starting with the sources mentioned above and relying on their experience, they developed learning outcomes that integrate both disciplinary and technological knowledge. The faculty continues to refine those outcomes by testing them in courses. (See Appendix 2.) In many instances, the outcomes span both the tangible and virtual, but some specifically address technology knowledge and skills. As noted above, no single set of skills will prepare students for all scenarios.

General Knowledge of Archives

Typically, newly enrolled students know a great deal about tangible records through their experience in school and in the workplace before they begin their professional education. They learned by observation, through use of the materials in their ordinary lives. They learned to read and write as children. They learned the basics of alphabetization and were familiar with common formats and genres long before they entered college. They need to become as comfortable and familiar with virtual records in the digital ecosystem as they are with the more familiar world of tangible records.

Even so, most students commonly come to the program with only a general, unsophisticated sense of records and archives. Many have limited work experience, with the result that they have not used a formal recordkeeping system and they have little appreciation for the roles of records and recordkeeping in a large organization. For example, students who have some experience with retail sales would have seen their own application and paychecks, and they might know something of receipts at the cash register. However, they may not appreciate that the corporate offices of a large chain has enormous volumes of applications and payroll records, nor would they likely see purchase orders to stock the warehouse, inventory control, marketing, and other records that grow out of routine processes. Before students can understand electronic recordkeeping, they need a more robust, general understanding of what constitutes a record and to learn about recordkeeping.

Similarly, students often have only a vague understanding of archives. They associate archives with historical (older) records. Many express an interest in pursuing a career in archives because they "love history" or enjoy genealogy. Because Clayton's program emphasizes digital archives, interviews with prospective students stress that the program – and prospective jobs – may not involve manuscripts from their past. Rather, they likely will be working with contemporary, digital records. Rather than entirely deromanticizing their misconceptions, the program encourages students to fall in love with the reality they will face as professionals. Students reframe their understanding of the profession as custodians of memory institutions and contemporary records as the future's history.

First and foremost, students need to understand the discipline in the larger context of the digital information ecosystem.[13] What is the difference between the tangible and virtual

[13] The metaphor of the digital information ecosystem was inspired in large part by Thomas H. Davenport and Laurence Prusak, *Information Ecology: Mastering the Information and Knowledge Environment* (1997). Diane Vogt-

world? In particular, how has the way people work changed? How are records created, used, and organized – by individuals and organizations? At the same time, fundamental concepts have been transformed. Tangible records are discrete objects with fixed information and clearly defined boundaries, while virtual records may exist as an assemblage of data elements scattered in multiple databases or files. Provenance and chain of custody for documents harvested from the web are different from tangible records acquired directly from a recordkeeper's office, but that difference may not be significant.

Similarly, the digital ecosystem includes how archives have changed in the digital era. Pearce-Moses has argued that while the fundamental goals of archivists' work remain the same, the way archivists work changes (2007). Archivists continue to identify and select, arrange and describe, house and preserve records, based on principles of provenance, original order, law, and ethics. Similarly, in light of the rise of digital humanities, data mining, and other research methods that take advantage of the affordances of digital archives, archivists must find new ways to support access for these innovative methods.

As much as possible, all courses incorporate the language of the *Reference Model for an Open Archival Information System* (ISO 14721) (Consultative Committee for Space Data Systems 2012) and *Audit and Certification of Trustworthy Repositories* (ISO 16363) (Consultative Committee for Space Data Systems 2011). For example, discussions of appraisal use the traditional terms accessioning and acquisition, but also use the OAIS terms ingest and submission information package. These standards map the digital information ecosystem. OAIS clearly describes the agents, actions, and objects necessary to ensure that electronic records remain accessible into the future, and the audit criteria articulate how those records remain trustworthy. Students are introduced to the OAIS model in the first class they take, principles and practices, and later they explore it in depth in a digital preservation course. Throughout the program, students investigate the nature of records and how traditional understandings have changed in the digital era. In a time when information is emphasized over records and fixity seems to be a chimera, students learn to distinguish records as persistent representations of information.[14] Students learn how fixity can be preserved and demonstrated in a digital environment, and – what is more important – how notions of persistence must be adapted to address preservation through migration.

Students learn about the intellectual, formal, and structural aspects of electronic records, and how those concepts translate into the digital ecosystem.[15] They work with records that contain structured and unstructured information. Records may no longer be individual objects, but atomized elements scattered in databases and file systems. Boundaries, especially in hypertext documents and databases, may be ambiguous. A single change to information in one place may result in unrecognized changes in many other records.

O'Connor and others explored that idea at the conference "The Information Ecosystem" (1998). The ideas are further considered in a special issue on the information ecosystem in *Cultural Resources Management* (1998).

[14] Definition based on Geoffrey Yeo, "The Concepts of Record" (2007).

[15] The program only touches on diplomatics, with reference to Luciana Duranti's work to help them analyze records in terms of their elements and structure.

General Knowledge of Technology

Students must understand the technical aspects the underlying infrastructure that supports the digital ecosystem. The majority of students entering the program are sophisticated consumers of technology. Many are digital natives, and all have used computers for years. However, many have limited technical skills, relying on family and friends when they run into problems. To thrive as digital archivists, students must learn about the internal workings of computers (and related technologies) and understand them as something other than an opaque black box.

The assumption that a new generation of digital-native archivists, born with a silver mouse in their hand, would know enough about computers to eliminate the need for digital archivists missed the mark. Rather, because modern computers' internal complexity is hidden under an easy to use interface means that the majority of students know little about the underpinnings of the system. In fact, they often know less about systems than early adopters who had to struggle with the command line, device drivers, complicated software, and hardware. Like driving a car, they can use computers to do many of the functions they are designed for – writing reports, sending email, browsing the web – without thinking about it because the systems are designed to be easy to use. As a result, they are not familiar with the internal workings of the system.

Digital archivists must know enough about the materials they work with to be able to acquire, manage, provide access to, and preserve collections of virtual records. By comparison, archivists working with tangible records know a fair amount about the nature and infrastructure supporting those records, although they may not have thought about it in those terms. On one level, many components of that infrastructure are so commonplace they haven not given them a second thought. It would be a rare person who was not familiar with bookshelves, boxes, folders, shelves, lights, and locks long before they considered being an archivist.[16] Over time, often on the job, they would realize that they needed to know more about the tangible records they worked with. They learned about the characteristics of different media (acidic papers and acid-neutral, lignin-free paper), signal (iron-gall, ball point, and felt-tip inks) for formats (letters, postcards, memoranda), as well as storage (low humidity and temperatures, low UV lights, appropriate materials for archival boxes). Archivists working with what used to be called non-traditional formats, such as photography, had to learn about media and signals specific to those formats (cellulose nitrate, diacetate, collodion, and gelatin, silver, platinum, dye-coupler), and sometimes specialized storage (freezers and bunkers).

Courses attempt to draw parallels between students' experiential understanding of the tangible, which is familiar, and the virtual, which is often new and strange. A tangible letter is a format that encodes information using alphanumerics in a specific language using ink (or similar) on paper, commonly 8.5 × 11 inches, that is inserted into an enveloped, addressed,

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[16] See Henry Petroski, *The Book on the Bookshelf* (1999) and *The Pencil: A History of Design and Circumstance* (1992) for explorations of the rich history of things most people take for granted.

then sent by postal service to a recipient, who opens the envelop and then reads it. By comparison, the virtual equivalent of email commonly uses a format (SMTP) that encodes information using a standard scheme (ISO 8859 or Unicode), is encapsulated (such as UUENCODING for attachments) and transmitted by internet service providers over wires controlled by various carriers, to a recipient, who uses a client to retrieve and read the message.

Technology Skills Related to General Knowledge

To learn about the digital information ecosystem, students build a Linux web server using Oracle VirtualBox as part of the first technology course. Configuring the (virtual) hardware requires them to think specifically about the CPU, hard drive, and input, output, and network devices normally hidden in the black box computer they bought at retail. Few students have experience with Linux, as most use Windows or OS X. Having students use an unfamiliar operating system puts many common tasks in a new perspective, making the familiar new, and forcing them to rethink what may have become rote behavior.

Students use the Xubuntu distribution, which comes with a graphical user interface, but much of the work is done from a command prompt. For example, in an assignment in the first technology course to install the Apache2 webserver, students use both the graphic Synaptic Package Manager and the apt-get command. Students use the graphic file manager, but also have to use the command line to navigate the file system using cd with absolute and relative paths, as well as mkdir to create new directories. Students have to configure software packages, typically modifying files in /etc. Students also have to execute some commands as root using sudo, as well as set permissions on directories. Using both graphic and command line tools helps students appreciate the underlying complexity of the system in terms of users, processes, and objects.

Ultimately, digital archivists must be as comfortable working with virtual records as they are working with tangible records. The infrastructure must become second nature to them. The principles and practices course was designed to parallel the archives and technology course, with the same content covered simultaneously but from different perspectives. When students study the characteristics of records in the principles course, they also study the characteristics of digital information in the technology course. Similarly, when they study arrangement in the principles course, they cover the file system in the technology course.

Appraisal, Selection, and Acquisition

The digital era does not change the fundamental goals of what archives collect so much as it gives archivists new opportunities to accomplish those goals. The content of records – tangible or virtual – drives what an archives collects. Few students come to the program with knowledge of how archivists assess the value of records. Initially, most equate appraisal with monetary valuation. As part of the introductory course, students learn a basic framework for assessing the value of records based on ideas of Jenkinson and Schellenberg, as well as more recent approaches. In other course, they continue to explore appraisal to discover how it influences other archival functions.

The appraisal course focuses on assessing the value of records, selecting those to be acquired, and, ultimately, the processes for acquisition and accessioning. In the course, they develop policies and procedures for a hypothetical university archives based on Clayton State University. Students use information on the university's website to understand its mission. Students identify potential record series for acquisition using a variety of methodologies, including documentation planning, macro-appraisal, and functional analysis. The analysis is largely based on university's public website. Students also have access to the university's intranet, which includes links to the university's academic, administrative, and student life. While students cannot access confidential information in the academic enterprise system, they are able to make some general decisions about the kinds of records in those system based on the ability to view their own records. Once identified, students recommend series that should be selected for acquisition.

While the process of acquisition tends to be relatively straightforward for tangible records, that process is considerably different and more complex for virtual records. Expressed simply, tangible files are transferred from filing cabinets to properly labeled boxes while preserving their original order. Archivists may use clerical staff to transfer tangible files and have immediate access to records storage. By contrast, virtual records in subdirectories and databases contain bytes that cannot be transferred using boxes. Instead, the archives may be given the original hard drives or tapes, asked to make copies on site, or to transfer the files via network. Transfer of virtual records in complex systems requires more advanced technical skills and may require support from a technologist. Further, as few large organizations are likely to give outsiders unlimited access to servers that hold both inactive and active records, digital archivists need to be able to communicate effectively with record creators' technical staff in large organizations to get the right records and metadata in an appropriate format. However, digital archivists should be able to transfer many virtual records themselves, especially when working with personal collections and small organizations.

Technology Skills Related to Appraisal, Selection, and Acquisition

As with tangible records, appraisal begins with a survey of the records to get a general overview of the collection or the series. That survey may include an interview with the record creators to get their perspective, but archivists often take time to look in file rooms, open file cabinets and boxes, and thumb through folder headings to get their own sense of the records. Archivists working with tangible records seldom have to explain the notion of 'record' to the record creators. By contrast, digital archivists may need to begin the interview by explaining to record creators that digital information is, in fact, a record. To accomplish that and to ensure that they can locate all (or at least most) of the records, digital archivists need to know enough about how electronic records are created, used, and managed in an organization, ranging from integrated, enterprise systems to idiosyncratic storage on personal hard drives and devices.

Given the importance of harvesting web content, students are introduced to the Arizona Model, a strategy to identify websites with potentially relevant content, and tactics to automate and track that process (Pearce-Moses and Kaczmarek 2005). Students use the Domain ID Tool, software developed by Pearce-Moses, which automates the process.

Students also review the underlying code as an example of how a very simple script can be very useful.[17]

Once records are selected for acquisition, digital archivists face a fundamentally different task. Virtual records will not be transferred from one tangible storage location to another, from file cabinets to transfer boxes, and then by truck from one building to the archives. In larger organizations, archivists will likely work with a system administrator to package the records for transfer. Creating submission packages may involve existing, individual files. In other cases, it will require an export from a database or enterprise system to a format that the archives can support, and the archivists may have to work with a database administrator to identify what constitutes records that are atomized and stored in several tables. In both cases, the archivists need to ascertain any series and subseries that need to be preserved.

On a practical level, students learn a variety of tools digital archivists need to do their jobs. For example, the tree command, WinDirStat, and Karen's Directory Printer can give the archivist a high-level view to help survey a file system.[18] To facilitate packaging records for transfer, they should be familiar with tools such as tar or zip. An assignment introduces students to BagIt and why its manifest with hash values help demonstrate the authenticity and integrity of the files after transfer.[19] Digital archivists may collect records from websites and social media, often without assistance from the record creators. To do that, they need to be familiar with services and tools such as the Internet Archive (Archive-It), wget, HTTrack, Xenu's Link Sleuth, and LinkChecker.[20]

Processing: Arrangement and Description

Original order may seem quaint in an age of databases, dynamic websites, and conglomerations of seemingly random text messages and social media posts. But, the principles of provenance and hierarchical organization of aggregates not only remain essential for context, they facilitate access.[21] Respect for the original order established by record creators, continues to provide context with which to understand those records and facilitate description. In some cases, provenance is tied to user accounts and their personal storage space. Arrangement based on series and subseries may be discerned from directories

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[17] See Richard Pearce-Moses, "A Tool to Discovery Web Content for Archives and Libraries" (2014). Note: the tool will be introduced in the appraisal and selection course in spring 2015.

[18] The tree command is native to Windows, Mac OS X, and other operating systems. GNU Software's version of tree for Windows is recommended over the native version (http://gnuwin32.sourceforge.net/packages/tree.htm). WinDirStat runs on Windows (https://windirstat.info/). Karen's Directory Printer runs on Windows (http://www.karenware.com/powertools/ptdirprn.asp).

[19] Library of Congress lists versions of BagIt for Java and Python, and Bagger, a GUI version on GitHub; https://github.com/LibraryOfCongress.

[20] The Internet Archive's Archive-It is a browser-based service accessible independent of operating system (www.archive-it.org). HTTrack Website Copier runs on Windows (http://www.httrack.com/). The Free Software Foundation's GNU wget is available for Linux, Windows, and Mac (http://www.gnu.org/software/wget/). Tilman Hausherr's Xenu's Link Sleuth runs on Windows (http://home.snafu.de/tilman/xenulink.html). Bastian Kleineidam's LinkChecker runs on Windows and Mac (http://wummel.github.io/linkchecker/).

[21] See Richard H. Lytle, "Intellectual Access to Archives" (1980) and David A. Bearman and Richard H. Lytle, "The Power of the Principle of Provenance" (1985).

or tagging. In some instances, order may not be apparent from the records themselves, but may only be discovered through interviews during appraisal.

Much of the work of arrangement and description is tied directly to submission and ingest. In the digital era, students learn basic "data wrangling", the process of transforming records and metadata received with those records into a form that the archives can manage. Given the differences between agencies, their work, and the records they keep, the submissions may be structured in myriad ways. The archivist must know what is minimally acceptable, based on the archives' needs and abilities, while simultaneously minimizing the impact on the transferring agency.

The well-established archival approach of describing series and subseries over items remains important and practical. Students learn how to describe aggregates of records, providing researchers with a synthesis of the materials to expedite research. The analytical skills of synthesizing an abstract may not be much different when working with virtual records. The archivist must be able to express the who, what, when, where, how, and why of the records. In fact, it may be possible for archivists' work with virtual records to be more efficient and effective than with tangible records. An archivist versed in tools common to most operating systems can quickly generate a precise inventory of the records. Given the vast quantity of digital records, Greene and Meissner's "More Product, Less Process" (2005) is even more important, and students must find ways to recognize, understand, and work with aggregates instead of individual files.

Technology Skills Related to Processing

To facilitate arrangement, students learn techniques to respect provenance and to recognize and preserve original order. The fact that the records are machine readable gives students a chance to learn ways to facilitate that process. Because the records are not eye-readable and file names are often so terse that they are meaningful only to the record creators, quickly scanning the files is not possible. At a minimum, using basic tools such as the tree command or a visual tool such as WinDirStat to document the directory structure used to organize the files, as well as to list the files in that context, is a reasonable and easy – if limited – first step. Recently, Clayton's program has started to look at other tools, although these have not been – and may not be – incorporated into courses. For example, Ed Summers' FONDZ (2014) "is a command line tool for auto-generating an 'archival description' for a set of born digital content found in a bag or series of bags." Andrew McCallum's MALLET (MAchine Learning for LanguagE Toolkit) (2002) can generate topic models, clusters of words that frequently occur together and that could be used to provide some clue as to the content of the documents. BitCurator (2014) is of particular interest as a way to introduce students to the principles forensic analysis that may be useful when processing collections.

In the arrangement and description course, students originally used Archivist's Toolkit to create finding aids; future students will use ArchivesSpace. In addition to learning how to use a tool that is widely adopted, the course uses the data architecture standard Encoded Archival Description (EAD) to introduce students to XML and mapping metadata.

The next course to be added to the curriculum will be a digital curation and preservation tools course in fall 2015. This course will introduce students to a wide range of tools, giving them the information they know to make strategic decisions about which tools to adopt, as well as intense, practical experience using the tools.

Reference, Access, and Outreach

With more and more patrons working online, students must learn how to provide reference services in a disintermediated environment. As with tangible collections, patrons often do not appreciate that indexing every name and subject in the records is beyond Herculean. Many patrons accustomed to Google may not understand why a simple search does not find documents; they likely have little appreciation for the complexity of OCRing digitized manuscripts to support keyword search. In a reading room, archivists can intervene and explain techniques to find relevant documents. In the absence of that immediate, personal connection, archivists must find new ways to help patrons find the records they want, ranging from FAQs for newcomers to live chat.

Similarly, archivists must find effective ways to provide access to records in an online environment. The task is more than digitizing born-analog documents or mounting virtual records. With the rise of digital humanities, scholars are discovering new ways to analyze and understand records, often integrating records from multiple sources. They may want those records in a variety of formats, or they may be as interested in access to the metadata.
A key lesson students learn in the program is the role of archives in the larger digital ecosystem, especially as more and more records are available online. Students learn how to use different social media tools, such as Facebook, Twitter, and Instagram. They develop a plan to use those tools to promote an archives and its collections. Rather than being a passive agent, students discover ways to become active agents, influencing – rather than merely being influenced by – surrounding people and activities.

Technical Skills Related to Reference, Access, and Outreach

Because social media tools are consumer oriented, students need little or no "hard" technology skills to use them to produce content. However, students must understand the affordances and limitations of the tools so that they can select appropriate methods to reach their audiences. As important, they must master "soft" skills, including developing an effective communication strategy and learning a writing style appropriate to the medium. The digital curation and preservation tools course under development will give students experience with additional technologies to reach broader audiences, such as Omeka for online exhibits and ViewShare to help patrons better understand the collections.

Preservation and Security

For archivists, preservation has two clear aspects.[22] First, preservation necessarily begins with record creators to ensure that records of lasting value are protected from accidental, innocent,

[22] See James M. O'Toole, "On the Idea of Permanence" *(*1989).

or malicious destruction, often as part of records management, appraisal, and selection. Second, archivists must protect those records transferred to the archives from deterioration and obsolescence so that they survive into the future.

The dual nature of preservation persists in the digital era. To ensure that records are not destroyed prematurely, archivists often have to help record creators recognize that digital formats are, in fact, records. For many record creators, email, tweets, and voicemail are fundamentally different from records. They see no need to preserve (keep) those casual communications or protect them from alteration because they do not perceive them to be formal records. Further, archivists must work with record creators to ensure that electronic records are trustworthy. Given how easy it is to edit and overwrite digital information, archivists often have to educate record creators about the importance of fixity. They must help the record creators understand how archives differ from backups and offline storage, even if the latter are often called archives.

Lectures and readings emphasize the social and behavioral nature of information and recordkeeping. JoAnne Yates' *Control through Communication* (1993) provides historical context for the relationship between records and systematic management. The National Archives' (2001 et seq.) reports on recordkeeping practices in the federal government gives students a realistic understanding of how difficult it is to get individuals focused on doing their jobs to comply with recordkeeping policies and procedures. Similarly, the loss of email at the United States Internal Revenue Service provides a significant, real-world example of the human and technical problems of recordkeeping in a digital environment.[23]

Once acquired, digital archivists must ensure that virtual records remain accessible for future use. Students learn about the challenges of digital preservation, ranging from hardware and software obsolescence to bit rot. Ironically, a significant amount of digital preservation centers on policies and procedures, rather than specific technologies. As noted above, OAIS and Trusted Digital Repositories provide a framework for those policies. Students learn strategies for digital preservation and to articulate goals that make it clear what it means to keep electronic records alive. The Digital Preservation course draws on the Digital Preservation Management Workshop (McGovern and Kennedy 2003 et seq.), which emphasizes organizational infrastructure and a resources framework, in addition to technological infrastructure.

In the end, policy guides procedures to ensure the longevity of virtual records. Digital preservation does not demand perfect fidelity any more than tangible media. Microfilm is a well-established medium for preserving paper records, even though color in the original images is rendered in black and white. Likewise, students must consider the notion of

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[23] See Sean Gallagher (2014), "Are lost IRS e-mails 'unbelievable'? Not really." This and related articles, along with the comments, clearly demonstrate the complexity of backing up systems. Technologists unfamiliar with the complexity of recordkeeping practices express naïve bewilderment that the system was not backed up. Students learn the practical realities of implementing technological systems within the human limitations common to many work environments.

electronic records' significant properties, what is essential to be preserved.[24] Migrating records to new software will frequently result in differences, such as a shift in font family or loss of bullets and other formatting. Even emulation is not immune to variances from the original. Students must be able to analyze the context of use to determine which losses are acceptable. Digital preservation is more than a reasonable rendering of the record. To be reliable, the archivist must find ways to preserve the records' trustworthiness and authenticity. Students are often unfamiliar with notions of reliable evidence, and examples of fraud and challenged documents help install new respect for the profession and nature of records.[25] In the same way that OAIS provides a reference model for a digital archives, PREMIS (2014) models the essential information that must be preserved beyond the bitstream to render the record and keep it accessible for the future.

Technical Skills Related to Preservation

Beyond understanding the theory of digital preservation, students learn practical application by using a variety of tools. As mentioned earlier, creating a virtual Linux system gives students experience with emulation. BagIt's use of hash values helps students understand the importance of documenting the integrity of files from original acquisition into the future. OpenOffice, used in batch mode, provides ways to migrate and normalize content. They also learn to use tools based on Droid and JHOVE for format identification. Finally, tools learned in other courses often directly support digital preservation.

Legal, Ethical, and Management Responsibilities

Students learn that, in the digital era, many of the basic issues of law, ethics, and management are not different so much as magnified. Access to personal information in tangible public records stored in a county courthouse may have practical obscurity that offers some protection of privacy. Making those records available on the web exposes the information to automated harvesting and data mining tools, demanding that archivists rethink the balance between access and privacy. Archives that place collections of records on the web are at risk for violating copyright (a risk much greater than in-house exhibits), and the archives must follow the same advice and warning they have routinely given patrons who might publish information in the records.

Most students have limited understanding of the legal process, and the courses in law and ethics and in records management emphasize the role of records in litigation and investigation. Readings emphasize that public records laws and discovery apply to records scattered on servers, individuals' workstations, and personal devices. To help students understand the judicial process and the implications of electronic records, they analyze documents from a trial that includes the initial complaint, discovery, a motion for a protective

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[24] See Webb, Pearson, and Koerbin (2013), "'Oh, you wanted us to preserve that?!'"

[25] Several readings are taken from *Authenticity in a Digital Environment* (Council on Library and Information Resources 2000). In particular, Peter Hirtle's "Archival Authenticity in a Digital Age" runs counter to many students' concern of theft with a story of salting the archival mine.

order, and the judge's opinion responding to a motion for sanctions resulting from the spoliation of email.[26]

Much of what students learn is to balance legal rights, public good, intent, and risk. Most orphan works were never intended for commercial use and the likelihood of litigation – along with a fair use argument – may trump concerns for copyright when deciding to put some records online.[27] The course in law and ethics goes beyond legal analysis, and introduces the ideas of Immanuel Kant and James Stuart Mill, giving students a framework to evaluate archival practice on the basis of respect for duty, individuals' dignity and autonomy, as well as the greater good.[28]

Finally, students also need some business acumen to appreciate what it means to manage technology in an archives. The digital preservation course and the management course both address the importance of planning sustainable programs. When working in the field, students must make choices among different technologies and evaluate them in terms of cost, maturity, and risk. For example, open source is often touted as "freeware", but the reality is that adopting those technologies often means significant investment in support, either in-house or from consultants. Contrariwise, commercial products from established companies are often seen as safer than open source tools that rely on a cadre of enthusiasts, when the reality is that commercial products may be discontinued or modified so that they are no longer practical.

Technical Skills Relating to Legal, Ethical, and Management Responsibilities

While the law and ethics course addresses potential implications of technology on archival practice, it currently does not include software tools. However, the faculty members plan to introduce students to forensics software such as FTK Imager, BulkExtractor, and FIWalk that are part of BitCurator to clarify the practical implications of privacy and personal identifying information in many virtual records.[29]

To help appreciate the costs of managing a sustainable system, students are asked to develop a budget for a digital preservation program, including checking online catalogs for servers and disk storage systems.

Technology Skills

Digital archivists do not have to master programming, database design, or system or network administration, but they must know enough to perform the core archival functions in the

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[26] See "Victoria Jones v. Bremen High School District 228" (2008).

[27] See Association of Research Libraries *Code of Best Practices in Fair Use for Academic and Research Libraries* (2012) and Society of American Archivists "Orphan Works: Statement of Best Practices" (2009).

[28] The author wishes to acknowledge and give thanks to Dr. Benjamin Lee Buckley, on faculty at Clayton State University, for his assistance in developing this part of the curriculum.

[29] BitCurator, mentioned above in the "Technical Skills Related to Processing" section (http://www.bitcurator.net/).

digital ecosystem. How much they need to know will vary, depending on the job. Lone arrangers must be a jack-of-all-trades, although they may be master of none. In small repository, a lone arranger may have to set up a small server, connect it to the network, and install software to advantage of common tools like ArchivesSpace, Omeka, or Dspace so they have appropriate tools to manage and store digitized and born-digital records. A professional database developer might create a database using MySQL with a web interface that simplifies data entry, and robust transaction tracking and rollback capabilities. Lacking access to such professional expertise, an archivist with basic skills could create a database that fulfills the same function – if less elegantly – using Microsoft Access. Capturing ephemeral records using a practical, if imperfect, solution is better than losing records while waiting for the perfect tool.

In larger institutions, digital archivists may need fewer skills as they may have access to professional programmers, system and network administrators, and others. Those technologists may be dedicated to the archives' work, or they may be in a support department. Even if the archivists are not responsible for the day-to-day operations of the systems, they must be actively involved in managing the systems to ensure that those systems meet the archives' needs. In the world of business and technology, keeping records five to ten years might be considered permanent. Archivists must engage the technology staff and remind them that good practices in business and technology do not always translate well to archives' requirements. Most important, the archivists must know enough to explain *why* those good practices do not translate.

The *New Skills* colloquium identified two distinct skill sets digital archivists need, "soft" and "hard." Archivists, especially those in management positions, need "soft" skills based in planning, management, and communication (Pearce-Moses and Davis 2008, 29). As noted in the colloquium's proceedings, archivists "needed these skills when working with traditional [tangible] materials. However, those skills often took on increased importance in a digital environment or had to be used in a different context." Integrating technology into all the core domain courses helps students master those soft skills. For example, an assignment in the management course includes planning and budgeting for technology in a grant proposal, and the digital preservation course emphasizes the social aspects of building a group with diverse skills to ensure records remain accessible over time. In the appraisal course, students learn about interviewing record creators as a technique to survey and understand the nature of collections being considered for acquisition.

In addition to soft skills, the *New Skills* colloquium identified "hard" skills, "the practical, technical skills that all library and records professionals must have to work with ebooks, electronic records, and other digital materials" (1). A number of participants suggested that the need for these hard skills would disappear as younger archivists came into the profession.[30] These new archivists would be digital natives, growing up with computers and be familiar and comfortable with all things technical. This assumption has proved to be only

[30] Author's recollection of the meeting, not included in the *Proceedings*.

partially accurate.[31] Using the introduction of the PC in the 1980s as a baseline, many archivists (and others) struggled to learn use word processors and spreadsheets. When first introduced, users were faced with a command line, and they had to learn a number of commands (often executed with the control, alt, or function keys – or a sometimes finger-twisting combination of the three). When users had problems with hardware, software, and printers, they were left to others in IT support or they became power users by mastering the basics of system administration.

At Clayton State, students are taught the basic concepts of programming. Simple bash scripts introduce students to variables, conditionals, and loops. The course Archives and the Web furthers those skills using PHP to retrieve and display content from a database. Faculty have considered requiring students to demonstrate skills by taking a test that asks the students complete simple tasks using a few common languages (Java, Basic, C, or PHP), using free, online programming tutorials, or to complete an undergraduate course in programming. Currently, one instructor offers a six week, no credit, no tuition "summer camp" that builds on the basic programming concepts in the archives and technology and archives and the web courses.

Pedagogical Principles for Teaching Archival Technology Online

No doubt, there are as many ways to teach courses online as there are to teach them face to face. Many teachers have reasonable reservations about the effectiveness of online courses, especially because many techniques instructors use in a traditional classroom do not translate well to an online environment. The question is not whether online education is effective, but which techniques are effective. One of the most important challenges in any environment is finding ways to engage the students.

For example, verbal sparring through a rapid exchange of questions and answers is difficult to adapt to online courses. Even high speed connections may suffer from network lag that breaks the rhythm of a conversation. Asynchronous discussions using bulletin boards lack spontaneity, making it harder to engage in a quick banter between the instructor and students to build to a point. Instructors may not have visual cues that signal who to call on to clarify an idea or share insight, and when it is time to move to the next idea. Similarly, students use body language to signal that they want to ask a question or make a comment without interrupting the instructor. Finally, students can use body language to engage each other, silently offering support and encouragement, or applying subtle pressure to get others to participate.

In the same way that teaching online is different, learning online is also different. In the same way instructors must learn new ways to teach online, students face similar challenges learning new ways to participate online. They must learn how to overcome the technical and social

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[31] See Alessio Maria Braccini, "Does ICT Influence Organizational Behavior" (2013). Although focused on emotional intelligence, Braccini reports that digital natives may be more comfortable with social aspects of technology, but gives no evidence that they have a greater understanding of the technology itself.

limitations of online classes. Fortunately, most students are patient with those limitations, as they recognize it is a reasonable price to pay for the convenience of not commuting to class. In order to meet the challenges of online education, teaching digital archives online involves two phases. First, presentation includes delivery of information to students. Second, application and integration gives students the opportunity to apply and internalize that knowledge based on practical scenarios.

Presentation

Classes introduce students to relevant knowledge and skills in a structured, logical sequence. Assigned readings in textbooks and journal articles are selected to familiarize students with core concepts, followed by lecture and class discussion to ensure they fully understand the ideas.

As with traditional, face-to-face classes, instructors present much of the information through live lectures in a virtual classroom. Starting in primary school, students are socialized in appropriate classroom behavior, ranging from how to sit attentively, how to ask questions, and how to engage in group discussion and exercises. To be effective in an online environment, students and instructors both must learn new manners of learning and teaching. As noted above, online lectures offer limited feedback from body language. Web cameras may make it possible to use facial expressions as a cue. However, students may not turn on their cameras due to limited bandwidth. Further limiting feedback, web conferencing software may limit the number of students the instructor can see at the same time. For example, WebEx shows no more than five video feeds simultaneously. Finally, because the cameras are typically focused on just the face, it is impossible to recognize cues from posture. Students also lack visual clues that encourage their participation. In the same way the instructor may not be able to see who has something to say, students may not be able to see the instructor encouraging to them to participate. As important, students cannot read the other students' expressions nudging them to respond.

Because it is easy for students to be passive in class, instructors must use different techniques to get them actively involved. Instructors commonly call on students. If the question is posed to all students, the response is often silence. No doubt, some of the delay may result from students taking time to think, and instructors have to learn patience with silence and to pause to give students that time. (Occasionally students may not respond because they are eating dinner and their mouth is full.[32]) Frequently, students begin to answer – to think aloud – in the chat box, which suggests who the instructor should call on.

One very effective technique is to get the group to respond to a question or scenario, getting them to collaborate through incremental responses, building to a fully developed synthesis of their individual contributions. The instructor introduces the question and calls on someone for an answer. The first individual often stumbles or gives a partial answer. The instructor calls on another student, asking the second student if he or she agrees, how they would

[32] Eating dinner during class is *not* discouraged. To the contrary, it is considered an effective use of time and – because the students are separate – it is not distracting to others.

modify or improve the answer. Repeating the process with subsequent students – each getting only a few minutes – avoids awkward silence and promotes social presence. Further, because the students know they may be called on at any time, they are more attentive to the discussion. This approach helps recreate face-to-face classroom interaction.

Another technique is to ask all students to raise their hand in response to a yes-or-no question (see **Figure 1**). Only the instructor can see the responses, and students are reminded that others don not see their response, minimizing students' concern of "saying something stupid." The question may be as simple as "Does this make sense?" so the instructor knows if it is time to move on. Controversial questions ("Who prefers Schellenberg's approach to appraisal over Jenkinson?") can lead to a good discussion. The instructor reports the aggregated response ("Several of you don't"), and the raised hand suggests students to call on to explain their response orally.

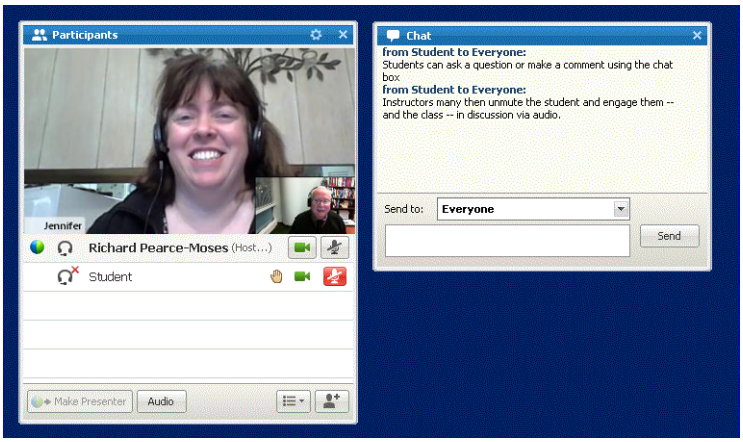

FIGURE 1.
Virtual Hand Raising

In online courses, lecturers and students seek equivalent signals to facilitate communication. This figure illustrates how students raise their virtual hand or post a comment in the chat box to get the instructor's attention to maintain classroom etiquette and to avoid possible miscommunication.

In tech courses (see **Figure 2**), lectures typically include live demonstrations of technology to illustrate content. As instructors talk through tasks in real time, they will inevitably make a mistake or run into some sort of technical problem. Similarly, during discussion of assignments, students may share their desktop with the class to get help with a problem. These scenarios provide a chance for students to observe how others work and pick up on

aspects not communicated verbally. Watching others work also models problem-solving behavior through a discussion of why something did not work. Simple problems, such as typos, demonstrate the importance of accuracy. More complex problems may require a web search, with a chance to provide commentary on ways to focus search results, identify authoritative sources, and read obtuse answers.

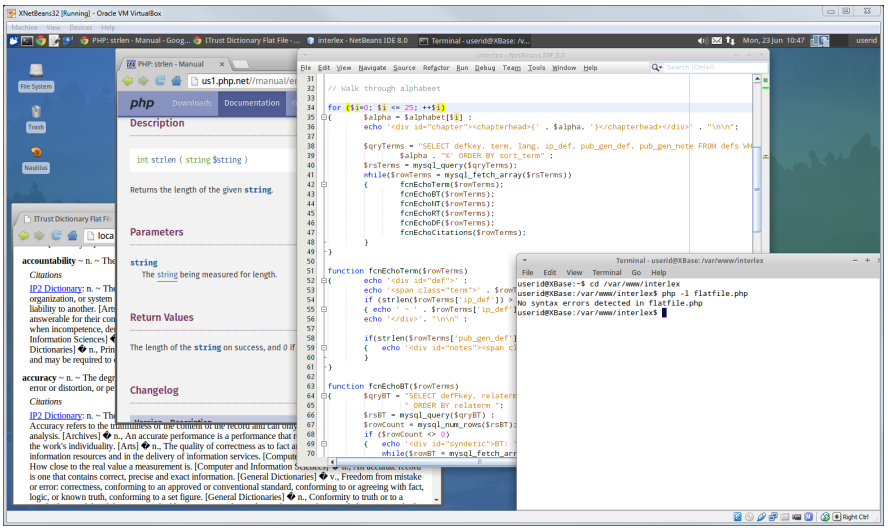

FIGURE 2.
Learning PHP

As illustrated in this figure, during the web course, students may see the instructor developing PHP code using Bluefish or Netbeans, testing it in a browser and using the command line, as well as searching online help.

Readings play an integral aspect of presentation. Many readings that focus on disciplinary knowledge are recent journal articles. To help ensure students integrate the knowledge, they are assigned one of the required readings to analyze. All reports are posted on a discussion board, and students are expected to read and comment on each other's reports before class. (The course management software allows the instructor to see if students have opened other posts.) To promote participation, as well as help the students become more comfortable speaking up in class, at least one student presents their report on camera each week. The reading reports ensure they are prepared for class discussion.

Students are expected to read everything assigned. Realistically, instructors recognize that students are busy and skim some readings. The reading reports ensure that they paid close attention to at least one article. Reading other students' reports helps students get the key

points on articles they have skimmed, providing different points of view and helping ensure they have caught the key points.

Readings that introduce technology include Robin Nixon's *Learning PHP, MySQL, JavaScript, and CSS* (2012) and David Evan's *Introduction to Computing* (2011).[33] Students also read portions of manuals, such as *Oracle VM VirtualBox User Manual* (Oracle 2004-2012), *Building a Simple Network* (Denniston 2002), and "Internetworking Basics" (Cisco 2009).

Readings from David Levy's *Scrolling Forward* (2011), Abigail J. Sellen and Richard H. R. Harper's *The Myth of the Paperless Office* (2002), and Neal Stephenson's *In the Beginning was the Command Line* (1999) place technology in the larger context of recordkeeping and introduce students to historical formats they may find in the collections. Ciaran B. Trace's "Beyond the Margin to the Mechanism" (2011) deserves special mention as a good introduction to the underlying infrastructure.

Because technical literature is often dense, lighter works in popular media, such as *Wired*, *Ars Technica,* and even *The Onion* (a satirical news website) illustrate the implications of technology of archives and recordkeeping. To help students appreciate technologists' humor, readings include Roy Callon's "RFC 1925 The Twelve Networking Truths" (1996) and David Waitzman's "RFC 2549 - IP over Avian Carriers with Quality of Service" (1999). These lighter works clearly engage the students through the amount of discussion they generate.

Application and Integration

As with traditional courses, assignments are overtly designed to teach students specific skills associated with digital archives. At the same time, those assignments help students integrate the ideas presented in lectures and readings.

Technology assignments given early in the program generally consist of detailed instructions with screenshots and a recorded demonstration students can watch. Faculty discovered it was easy for students to mimic what they saw on the screen, step by step, without fully understanding why they were taking those steps. To further ensure students have mastered concepts, faculty revised assignments to gloss over skills detailed in earlier work. Students who didn't master the skills in previous assignments are told to review the earlier assignments.

Many of the assignments might be characterized as "sink *and* swim." Students presented with a complex assignment (by analogy, thrown into the deep end) must do their best to figure out the solution on their own. This approach is designed to imitate real world scenarios, where an archivist tackles a difficult technical problem by deciphering instructions that may be incomplete and reading web forums that are unclear or outdated. A key outcome here is to learn problem solving by building effective searches and identifying authoritative sources.

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[33] Because the current edition of Nixon uses older, deprecated code, faculty are looking for a different text.

Unlike the "sink *or* swim" approach, students can call for a life preserver when they get stuck. Virtual office hours using web conferencing allows students to share their desktop so the instructor can see what the student is doing. These scenarios often provide a chance to identify and discuss mistakes that may not be addressed in lecture or assignments. Because students are new to technology, they do not yet have the knowledge to be able to report what they are doing accurately. As a result, it is difficult for the instructor to identify what the students do not understand. In many cases, the problems are immediately apparent when the instructor observes the student working on their virtual machine. For example, a student may describe a command they have typed as c-d-slash-e-t-c-slash-apache2. If the instructor can see the screen, the problem may be immediately apparent; for example, the student used a back slash (\) instead of slash (/), or inserted or omitted spaces.

Originally, in the technology course, one of the first assignments was to install Archon. By comparison, installing Archivist's Toolkit, a similar and more popular application, was relatively easy. Archon was chosen for the assignment precisely because installation involved several complicated steps that helped students understand the inter-relationship of software and system administration. Installing Archon required separate installation of the Apache2 webserver, the MySQL database server, and PHP, including manually editing configuration files. Students also had to configure users, directories, and permissions, tasks few were familiar with on single-user machines. With the merger of Archon and Archivist's Toolkit into ArchivesSpace, which is easy to install, the program is looking for an alternative assignment to give the students the same knowledge.

General Rubric to Assess Proficiency

Questions of what students need to know are directly tied to how thoroughly they need to understand the subject. Digital archivists may need a range of technical skills, but that does not mean that they need to be programmers, systems administrators, or database designers. Similarly, they do not necessarily need advanced data analysis skills used in the digital humanities, but they need to know the basics to help patrons understand possibilities for research. Clayton's Archival Studies program evaluates students' mastery of the material using three, broad criteria: fluency, basic competency, and proficiency.

Fluency

For minimum, acceptable work students must achieve a basic fluency. At this point, students are able to list the elements of core knowledge and skills, but with incomplete explanation or some errors in application. They have limited ability to relate that knowledge to other aspects of archivy. They have demonstrated limited ability to apply that knowledge in simple situations or to use best practices. At a minimum, fluency enables students to have intelligent conversations about the issues of digital archives with technologists. They have to be able to talk tech. If not, they cannot properly explain system requirements to those with the skills to build those systems. As important, they cannot understand what the technologists have built to know if it is adequate and truly does what needs to be done.

Unless an archivist can explain the problem carefully, in technical terms, a programmer may make assumptions – reasonable assumptions – that fall short of needs for curation or

preservation of electronic records and managing digital archives. For example, an archivist may want to store metadata in the archival information package to ensure the metadata is tightly coupled to the records and cannot be easily disassociated, as well as in a database for rapid access. A programmer may see an opportunity to streamline processes, save space, and normalize data by including a link to the metadata in the database rather than duplicating that metadata in the package. The programmer's decision is reasonable and likely conforms to industry best practice, but archives are not typical and have different requirements.

An archivist who can speak intelligently about technology will find it easier to work with technologists. The technologists do not have to spend time explaining what is, to them, basic concepts. If the archivist clearly understands the ideas, the work is more efficient because communication is more effective. Patricia Galloway has suggested that, as a result of using technologists' language, the technologists begin to see the archivists more sympathetically as a member of their "tribe" rather than an outsider.[34]

As important, vocabulary gives archivists the fundamental tools to conceptualize technical solutions to problems. They may not know how to build a tool, but if they can describe the tool's functionality – how it should manipulate information and records – they may be able to articulate creative solutions a technologist would not have thought of. Further, only archivists know the pressure points, problems that need to be solved. Unless technologists are actively involved in archives, they won't likely be aware of things that need solutions.

Basic competence

To meet expectations, students must achieve basic competence. They are able to describe the theoretical aspects of a problem in some depth and apply practical skills with few problems. They are able to relate that knowledge to other aspects of archivy. They can demonstrate the ability to apply that knowledge in common, typical situations and to apply appropriate best practices.

Students must be able to do tasks roughly equivalent to traditional archival work, but with virtual records. They must be able to transfer records from one location to another, arrange and describe them, house them for long-term storage, help patrons locate and make sense of the records, and ensure the records remain accessible over time. Students must be able to package virtual collections on a record creator's computer and transfer them to the archives using appropriate software tools and media. They must be able to arrange and describe those collections, making sense of non-tangible formats and the manner in which the records are organized. They must be able to take basic steps to stabilize the records, selecting appropriate techniques such as migration or normalization for long term storage. Students must be able to plan and oversee a digital preservation program, working in concert with technologists who have specialized knowledge.

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[34] Patricia Galloway. Personal conversation with the author about 2007.

Proficiency

Exemplary students exceed basic competence. They are able to discuss theoretical concepts in depth and apply practical skills completely and accurately. They have demonstrated the ability to engage that knowledge by placing those ideas in context, integrating and synthesizing them with other aspects of archivy and other disciplines. They demonstrate original insights and novel application of ideas and practices, and they are able to evaluate an ambiguous, complex situation to apply appropriate best practices.

Few students will become truly proficient during their studies. Mastering digital archives takes a lifetime. Classes can give students only limited experience with the diversity of records and scenarios they will face in their jobs. However, in many instances, students clearly demonstrate a spark of proficiency. They apply knowledge in a novel context, suggest innovative approaches, and offer novel perspectives.

Assessment

The program uses a formal assessment plan to determine if the students have achieved the program's outcomes. That plan uses exams and papers to determine if students can define terms and explain concepts. The plan also uses assignments to demonstrate students' ability to apply technical skills in a variety of contexts, such as implementing and configuring a virtual server or building a web page. For example, the Archon assignment allows the instructor to see if students can navigate the file system, manage users and permissions, edit configuration files, and distinguish a standard user from the super user.

In addition to formal assessment, one informal measure illustrates these courses' success. By the end of the first course, students are able to parse commands. At the beginning of the technology courses, instructors have to be explicit when describing commands. For example, when talking about a step in an assignment early in the semester, the instructor might have to remind students not to type the prompt, often have to spell out commands and explicitly mention spaces ("s-u-d-o space c-h-m-o-d dash capital R"), and remind students to use the forward slash instead of the back slash. By the end of the semester, students are sufficiently familiar with the vocabulary and syntax that the instructor does not need to be as exact; the students are familiar with the commands and spacing, so the instructor can communicate more effectively ("sudo chmod -R g+w . . .").

The program is expanding the formal assessment as part of a capstone course students take during their last semester in the program. In that course they review the fundamentals of each of the core domains and complete assignments to demonstrate ability. At the end of the course, students take a comprehensive exam consisting of five questions. Students have two weeks to complete the exam, with the expectation that the response to each question will be between 500 and 750 words. The students' responses are evaluated on their use of relevant, professional language, the ability to thoroughly explain core archival concepts, and to reference the literature within the discipline.

Conclusion

Clayton's program is in its fifth year, and courses have been offered online for four years. The program has grown from infancy to adolescence. Although relatively new, Clayton's experience can serve as a model for other programs, in the United States and other countries. Other programs can adapt syllabi and assignments in order to incorporate more technology into their curricula or to create fully online or hybrid courses that combine face-to-face and online components.

The program is committed to continuous improvement. The learning outcomes and pedagogy continue to evolve. Each time instructors teach a course, they discover new ways to improve the content and to better employ engaged learning in online learning environments. Likewise, instructors constantly seek new ways to integrate technology in each archival studies course and to ensure technology components remain current. Often, it means creating new assignments to use software tools that immerse students in the practical application of core concepts presented in class.

Beginning in fall 2015, the program will begin a formal review process to determine areas that are effective and should be continued, as well as areas that need to be improved. The program will explore asynchronous courses in 2015 for students who cannot attend live classes. It is looking at partnerships with the library school at Valdosta State University and with public history programs in Georgia. Graduates will be invaluable resources to determine how well their education prepared them for their jobs. The advisory board needs to be reconstituted to get input from prospective employers.

Faculty strive to give students more than a strong foundation in the theoretical and practical aspects of archives. They also strive to provide students the knowledge and skills needed to be more than sophisticated consumers of technology. They do not need to be full-fledged systems engineers or administrators. They will not be qualified for technical jobs, such as software developers or database designers. Rather, as digital archivists, students need to be something akin to a shade-tree mechanic or a tinkerer who can perform basic archival functions while working with electronic records. For example, they must know enough to ensure that digital systems they use are backed up and what constitutes a sufficient backup – and they may need to back up their own systems if they are a small shop with little or no technical support; but they do not have to know everything.

Students learn about the internal workings of the computer, what goes on "under the hood," and have a better understanding of the digital information ecosystem because they know how it works. The key outcome is that students learn to be self-reliant. They are not dependent on commercial applications or an IT professional.

In the same way that archivists working with tangible materials do not have to be experts in the production of tangible media, they must become equally familiar with the affordances and problems of digital information and digital storage. In the same way that archivists have learned the interrelationship between infrastructure and records in the tangible realm, digital

archivists must understand the interrelationship between the technical infrastructure and virtual records.

The program's instructors feel confident that students have a strong foundation based on the knowledge and skills necessary to work as digital archivists. The students will not know everything when they graduate. It is impossible to concentrate years of experience into a few courses. However, they know enough to understand a wide range of scenarios, make a reasonable decision about solutions, and continue their education to get the knowledge and skills tools necessary to ensure valuable records remain accessible into the future.

APPENDIX 1.
Courses

The chart below (**Table 1**) notes the domains emphasized in the courses. Given the interconnected nature of archival work, most courses touch on several domains, but the chart notes only the principal domains. For example, as the foundations course, Principles and Practices introduces all the domains but only "General Knowledge" is checked. Similarly, the Appraisal and Selection course covers legal aspects of acquisition, which are also covered in the Law and Ethics course. The Reference, Access, and Outreach course and the Law and Ethics course both address issues of privacy.

TABLE 1.
Core Archival Courses

		General Knowledge	1. Selection, Appraisal, Acquisition	2. Arrangement, Description	3. Reference, Access	4. Preservation, Protection	5. Outreach, Advocacy, Promotion	6. Managing Programs	7. Professional, Legal, Ethical Responsibilities	Technology (not part of ACA role delineation)
Core Archival Courses	ARST 5000: Principles and Practices	x								
	ARST 5400: Records Management		x							
	ARST 5500: Appraisal and Selection		x							
	ARST 5200: Arrangement, Description			x						
	ARST 5170: Reference, Access, Outreach				x		x			
	ARST 5150: Preservation					x				
	ARST 5300: Digital Preservation					x				x
	ARST 6620: Managing Archives							x		
	ARST 6610: Law and Ethics								x	
Technology Specific Courses	ARST 5100: Archives and Technology	x								x
	ARST 5110: Archives and the Web	x								x
	ITFN 5000: Database Design									x
	ARST 5250: Digital Curation, Preservation Tools			x		x				x

Virtually all courses touch on technology at some level. For example, in Arrangement and Description, students install and use ArchivesSpace (formerly Archivist's Toolkit) and in Digital Preservation, they use simple tools to harvest websites.

In addition to the courses listed above, students take courses in research methods, an internship or directed research, and a capstone course that includes a comprehensive assessment exam. Students have a thesis option.

APPENDIX 2.
Program Learning Outcomes and Select Course Outcomes Tied to Technology

Program Outcomes

- To explain the value and role of archives in government, business, and society, and to analyze the nature and use of records as evidence and cultural memory.
- To appraise and acquire records in all formats by identifying and synthesizing a variety of approaches in order to build trustworthy collections that provide a comprehensive, accurate, and authentic understanding of the past.
- To arrange, describe, and support discovery of archival materials by identifying and applying best practices and standards.
- To provide reference service to diverse patrons by evaluating their information needs and recommending relevant records.
- To preserve traditional and digital archival materials and to design a program to protect records.
- To apply legal and ethical principles in order to protect privacy, intellectual property, and other interests associated with the collections.
- To explain and demonstrate how technology has transformed the nature of records and archival practice.

Course Descriptions and Outcomes

Lectures, readings, and assignments address all aspects of tangible and digital archives. The abridged list below discusses of how technology is incorporated into course outcomes. Note, also, that course outcomes are currently being revised as part of a commitment to continuous improvement. The list below reflects current discussions, and may not match previous or upcoming syllabi. A full listing of courses with complete course descriptions and syllabi for many courses are available at http://www.clayton.edu/mas/courses.

In addition to the courses listed below, students take three others: internship or directed research, a capstone, and research methods.

ARST 5000 · Principles and Practices

Introduction to the fundamentals of archival theory and functions, including core domains of selection, appraisal, and acquisition; arrangement and description; reference services and access; preservation and protection; outreach, advocacy, and promotion; managing archival programs; and professional, ethical, and legal responsibilities. Emphasis on the importance of key archival principles, including respect for provenance, original order, authenticity, evidence, and value. Examination of the different types of archives and the formal, physical, and technical characteristics of records in a wide range of formats. Discussion of the importance of historical records, the role of archives in society, and the nature of records and recordkeeping systems.

- Explain and evaluate the characteristics of records and discuss how the concept of record varies in different contexts.
- Discuss the different kinds of archives and records programs, distinguish them from other cultural memory institutions, and explain their role in society.
- Explain key archival concepts, terms, principles, practices, and methods (for example, provenance, original order, trustworthiness, authenticity, integrity).
- Describe and discuss the professional responsibilities of archivists, including legal and ethical obligations.
- Explain core archival functions (selection, appraisal, and acquisition; arrangement and description; reference services and access; preservation and protection; and outreach, advocacy and promotion) and discuss how they relate to each other and influence the administration of archival programs.

ARST 5100 · Archives and Technology

An overview of information technology concepts and introduction to practical skills. The course is designed to complement Principles and Practices, with a discussion of the influence of technology on archival theory, method, and practice. The course emphasizes an understanding of the digital ecosystem, rather than preparing them to work as system or network administrators, programmers, or database developers. However, it gives students enough information to do many simple tasks on their own and to be able to download, install, and play with archival software so they can determine its potential value. In small shops without access to tech support, they should be able to install, maintain, and use many tools.

- Discuss the parallels between tangible and virtual records and recordkeeping systems, and the impact of technology on the profession.
- Discuss the technical infrastructure of digital systems.
- Describe the basic concepts of programming and write simple scripts to automate tasks.
- Discuss structured and unstructured data formats.

ARST 5110 · Archives and the Web

Similar to Archives and Technology, the course focuses on understanding the web as an environment where recordkeepers create, store, and make records accessible, and the nature of web records and the challenges of preserving web content. Students can create a simple site or maintain a more complex site developed by others, but the course emphasizes the web as a source of records and the nature of "record" in the context of hypertext.

- Analyze the nature of web content as records with content, context, and structure.
- Describe the technical infrastructure of the internet, including common strategies and technologies used for web content.
- Apply core web standards and best practices to create websites and pages.
- Demonstrate the common approaches to web capture and their impact on preservation and access.

ARST 5150 · Preservation of Archival Records

This course focuses on tangible formats, rather than virtual records, including physical characteristics, risks to preservation, and how preservation should be integrated into all archival functions. Some concepts, such as preservation ethics, inherent vice, security, preservation planning, and emergency response overlap. The course introduces digital reformatting.

- Explain the factors that affect the longevity of records.
- Develop a disaster preparedness plan.
- Discuss decisions about retaining records in their original format or copying to a new format and relate how institutional context and resources affect such decisions.
- Propose a preservation program for tangible records, including the elements of a digital reformatting operation.

ARST 5170 · Reference, Access, and Outreach

This course explores methods to provide effective customer service in archives, with an emphasis on the shift from face-to-face to online research and access. The course addresses how issues of privacy and copyright shift when mounting collections of digitized or born-digital records on the web. Finally, the course encourages techniques to make the archives visible and valued to patrons and resource allocators.

- Discuss emerging trends in research and techniques to assist patrons in various types of research.
- List and describe tools to provide access to an archives' holdings.
- Demonstrate the use of social media to promote the use of archives.
- List, describe, and evaluate different approaches to advance understanding of archival work and programs to resource allocators and the public.
- Define advocacy, public relations, and fundraising, and discuss their utilization in communicating the value of archives to others.

ARST 5200 · Arrangement and Description

This course covers the intellectual and physical organization of records in all formats based on the archival principles of respect for provenance and original order, hierarchical organization, and management of aggregates over items.

- Discuss how modern records collections and evolving technology have influenced archival theories of arrangement.
- Plan and manage a processing project effectively, including creating a processing plan.
- Describe a variety of methods used to provide access to archival collections, including guides and finding aids.

- Apply and cross-walk a variety of metadata standards and their applications, including DACS, EAD, MARC, PREMIS, and Dublin Core.
- Arrange an archival collection that contains multiple formats, including text, graphics, and audio, in tangible, digitized, and virtual formats.

ARST 5250 · Digital Curation and Preservation Tools (Starting Fall 2015)

This course provides an in-depth analysis of variety of common tools not covered in other courses, such as Archivematica, BitCurator, Dspace, Omeka, and Drupal. Includes managerial perspectives relating to evaluation of functionality, licensing, costs, and implementation, including requests for proposal, development, and collaboration with IT staff. Examination of specific tools to support digital repositories and content management systems, digital forensics, migration, emulation and virtualization, archives management, and data analysis.

- Analyze tools and be able to make recommendations for use in different contexts.
- Describe tools frequently used in digital curation and preservation.
- Install and use tools used in digital curation and preservation.

ARST 5300 · Digital Preservation

This course offers an in-depth analysis of the challenges of keeping electronic records accessible over time, and of the Open Archival Information System and Trusted Digital Repository standards. Students develop a digital preservation plan that addresses administrative responsibilities, organizational viability, financial sustainability, technological suitability, system security, and accountability.

- Discuss fundamental concepts of digital systems, including layered representation, dependencies, and interfaces.
- Describe the threats to the long-term preservation of digital objects.
- Describe a workflow for digital archives, including objects (submission, archival, and dissemination packages), roles, and functions.
- Discuss trustworthiness, authenticity, reliability, usability, and comprehensiveness, as well as form, uniqueness, and quantity in the context of digital records.
- Design a disaster prevention program, including response and recovery procedures, for digital archives.
- Understand the range of options for preserving records in their original format or structure, and when to utilize other preservation strategies and action plans for digital files.

ARST 5400 · Records Management

This course addresses the management of active and inactive records still in the custody of the record creators, including building relationships with the record creators to ensure records are kept for the appropriate period of time, determining retention periods, and developing schedules. The course also addresses legal considerations, including preservation holds and spoliation.

- Discuss the principles and core functions of records management and the impact of social, economic, and technological factors.
- Discuss the relationship between records management and archives.
- Manage the records life cycle management processes, controls, and systems.

ARST 5500 · Appraisal and Selection

This course explores the notion of the value of records in depth, and introduces methods to identify, evaluate, and acquire records in all formats that merit enduring preservation. Review of methodologies to guide appraisal work and to make informed professional decisions concerning the selection and acquisition of archival material. Students develop a collecting policy that begins with a vision and mission statement, and includes documentation planning and developing criteria to assess the relative value of collections.

- Plan strategies to systematically meet clearly defined goals that reflect the archives' vision, values, mission, and collecting policies.
- Evaluate strategies to ensure they address the inter-relatedness and sometimes conflicting imperatives of the archival enterprise (for example, how arrangement and description, preservation, reference and use, and legal and ethical factors influence value).
- Develop policies and procedures (tactics) to implement the strategy in a way that goes beyond building collections, and supports all archival activities.

ARST 6610 · Law and Ethics

This course covers legal and ethical issues likely to arise in an archives, with an emphasis on copyright, privacy, and public records laws. The course examines these issues from both a legal perspective, as well as a framework built on Kant's deontology and Mill's utilitarianism. Students learn the ethical responsibilities of a professional archivist to protect the rights and interests of the archives, record creators, donors, and other individuals and organizations documented in the collections.

- Identify and evaluate legal risks in all areas of the archival enterprise, including intellectual property, privacy, and public records laws.
- Develop policies and procedures that facilitate the archives achieving its mission, while balancing the ethical rights and interests of all stakeholders in accordance with the Society of American Archivists' Code of Ethics and Statement of Values.
- Identify and evaluate ethical concerns of all stakeholders in all areas of the archival enterprise.

ARST 6620 · Managing Archives

An introduction to general principles of management, including planning, budgeting, staffing, and facilities. Also includes grant writing and administration.

- Discuss the use of policy, procedure, and communications to support systematic management and planning in an archives.
- Apply principles of leadership and human resources to effectively supervise personnel and programs.
- To discuss the challenges of managing facilities, including an analysis of security, return on investment, and technology operations.
- To manage financial resources and manage budgets.

ITFN 5000 · Database Design for Archives

This course introduces the basic concepts of data modeling and the implementation of simple databases.

- Explain database concepts and terminologies related to archives.
- Identify information needs within an organization.
- Identify, specify, and modeling user and organizational requirements.
- Develop skills to construct a logical model that supports specified requirements.
- Transform and implement database design on a physical database.
- Write fundamental SQLs maintain archival data in database
- Master fundamental database design models.

ABOUT THE AUTHOR

Richard Pearce-Moses was the founding director of the Master of Archival Studies program at Clayton State University in Morrow, Georgia. He is a past president and fellow of the Society of American Archivists and a certified archivist. He has worked in the field for more than thirty years. He was Deputy Directory for Technology and Information Resources at the Arizona State Library, Archives and Public Records in Phoenix, Arizona. He has also worked as an archivist at the Heard Museum, Arizona State University Libraries, the Texas State Library and Archives, and the Texas Historical Foundation, and the Harry Ransom Center at the University of Texas at Austin. For the past decade, he has focused on the problems of digital records. In 2008 the Library of Congress named him a Digital Preservation Pioneer, and in 2007 he received the Kilgour Award for Research in Library and Information Technology. Pearce-Moses retired in July 2015, but is affiliated faculty at Clayton State, continuing his research as part of the InterPARES Trust project and working with students. A full resume can be found at http://home.comcast.net/~pearcemoses/.

Bibliography[35]

Academy of Certified Archivists. 2012. *Handbook for Archival Certification.* Albany, NY. http://www.certifiedarchivists.org/wp-content/uploads/2013/07/handbook.pdf.

Association of Research Libraries. 2012. *Code of Best Practices in Fair Use for Academic and Research Libraries*. Washington, D.C. http://www.arl.org/storage/documents/publications/code-of-best-practices-fair-use.pdf.

Bearman, David A., and Richard H. Lytle. 1985. "The Power of the Principle of Provenance." *Archivaria* 21: 14-27. http://journals.sfu.ca/archivar/index.php/archivaria/article/view/11231/12170.

Birkel, Garrett. 2004. "The Command Line in 2004." http://garote.bdmonkeys.net/commandline/index.html.

Botticelli, Peter, Bruce Fulton, Richard Pearce-Moses, Christine Szuter, and Pete Watters. 2011. "Educating Digital Curators: Challenges and Opportunities." *The International Journal of Digital Curation* 2 (6): 146-164. http://ijdc.net/index.php/ijdc/article/view/188.

Braccini, Alessio Maria. 2013. "Does ICT Influence Organizational Behavior: An Investigation of Digital natives Leadership Potential." In P. Spagnoletti (ed.), *Organizational Change and Information Systems*. Springer-Verlag Berlin Heidelberg: 11-19.

Callon, Roy. 1996. "RFC 1925: The Twelve Networking Truths." Network Working Group. http://www.faqs.org/rfcs/rfc1925.html.

Cebula, Larry. 2013. "An Open Letter to the Historians of the 22nd Century: Sorry for all the Stuff." *Slate* (22 July 2013). http://www.slate.com/articles/arts/culturebox/2013/07/how_will_historians_of_the_future_sort_through_the_data_glut_of_the_present.html.

Cisco. "Internetworking Basics." 2009. http://docwiki.cisco.com/wiki/Internetworking_Basics.

Consultative Committee for Space Data Systems. *Audit and Certification of Trustworthy Repositories.* 2011. http://public.ccsds.org/publications/archive/652x0m1.pdf.

———. 2012. *Reference Model for an Open Archival Information Systems*. 2012. http://public.ccsds.org/publications/archive/650x0m2.pdf.

Council on Library and Information Resources. *Authenticity in a Digital Environment.* 2000. Washington, D.C. http://www.clir.org/pubs/reports/reports/pub92/pub92.pdf.

Davenport, Thomas H., and Laurence Prusak. 1997. *Information Ecology: Mastering the Information and Knowledge Environment*. New York: Oxford University Press.

Denniston, Ken. 2002. "Introduction to Networking." *Building a Simple Network*. Intel Press.

Dooley, Jackie. 2014. "What does a digital archivist do?" *HangingTogether.org* [blog]. OCLC. http://hangingtogether.org/?p=3901.

Evans, David. 2011. *Introduction to Computing: Explorations in Language, Logic, and Machines*. http://computingbook.org.

[35] All URLs checked 27 May 2015.

Fulton, Bruce, Peter Botticelli, and Jana Bradly. 2011. "DigIn: A Hands-On Approach to a Digital Curation Curriculum for Professional Development." *Journal of Education for Library and Information Science* 52, no. 2: 95-109.

Gallagher, Sean. "Are lost IRS e-mails 'unbelievable'? Not really." 2014. *Ars Technica*. http://arstechnica.com/information-technology/2014/06/are-those-lost-irs-emails-unbelievable-not-really.

Greene, Mark A., and Dennis Meissner. 2005. "More Product, Less Process: Revamping Traditional Archival Processing." *American Archivist* 68, no. 2: 208-263. http://americanarchivist.org/doi/pdf/10.17723/aarc.68.2.c741823776k65863.

Hockney, David. 2011. "Photoshop is Boring." Humlebæk, Danmark: Louisiana Museum of Modern Art. http://youtu.be/oAx_aYGmpoM.

Honan, Mat. 2012. "How Apple and Amazon Security Flaws Led to My Epic Hacking," *Wired* [online]. http://www.wired.com/gadgetlab/2012/08/apple-amazon-mat-honan-hacking/all.

"The Information Ecosystem: Managing the Life Cycle of Information for Preservation and Access, College Park, Maryland, March 10-13, 1998." Sponsored by the National Park Service Museum Management Program and National Register of Historic Places, the National Archives and Records Administration.

Kim, Jeonghyun, Edward Warga and William E. Moen. 2013. "Competencies Required for Digital Curation: An Analysis of Job Advertisements," *International Journal of Digital Curation* 8, no. 1: 66-83. http://www.ijdc.net/index.php/ijdc/article/download/8.1.66/317.

Lee, Christopher A. (Cal). 2009a. "Matrix of Digital Curation Knowledge and Competencies (Overview)." DigCCurr. http://ils.unc.edu/digccurr/digccurr-matrix.html.

Lee, Christopher A. (Cal). 2009b. "Curation Junction, What's your Function? Defining What It Means to Do Digital Curation in Order to Teach It." *Proceedings of the 2009 Annual Conference of the Association for Library and Information Science Education (ALISE)*. http://www.ils.unc.edu/digccurr/alise2009-lee.html.

Levy, David M. 2011. *Scrolling Forward: Making Sense of Documents in the Digital Age*. New York: Arcade.

Library of Congress. 2010. "Digital Preservation Outreach and Education (DPOE) Training Needs Assessment Survey: Executive Summary." http://digitalpreservation.gov/education/documents/DPOENeedsAssessmentSurveyExecutiveSummary.pdf. An overview of the DPOE is available from the Internet Archive at https://web.archive.org/web/20110307115746/http://www.digitalpreservation.gov/education/. A follow up, the "2014 DPOE Training Needs Survey" Report," was published 14 December 2014. http://www.digitalpreservation.gov/education/2014_Survey_Report-Final.pdf.

Lytle, Richard H. 1980. "Intellectual Access to Archives: I. Provenance and Content Indexing Methods of Subject Retrieval." *American Archivist* 43, no. 1: 64-75. http://americanarchivist.org/doi/pdf/10.17723/aarc.43.1.31031523737j16n7.

McCallum, Andrew Kachites. 2002. "MALLET: A Machine Learning for Language Toolkit." http://mallet.cs.umass.edu.

McGovern, Nancy Y., and Anne R. Kenney. 2003 to present. "Digital Preservation Management: Implementing Short-term Strategies for Long-term Problems." Originally

developed by Nancy Y. McGovern and Anne R. Kenney at Cornell University 2003-2006. Extended and maintained by Nancy Y. McGovern at the Interuniversity Consortium for Political and Social Research (ICPSR), 2007-2012 and by the MIT Libraries beginning in 2012. http://www.dpworkshop.org/.

National Archives and Records Administration. 2001. *Report on Current Recordkeeping Practices with the Federal Government*. http://www.archives.gov/records-mgmt/faqs/pdf/report-on-recordkeeping-practices.pdf. Subsequent reports were issued in 2010, 2011, and 2012.

Neal, James G. 2006. "Raised by Wolves: Integrating the New Generation of Feral Professionals into the Academic Library," *Library Journal* 131, no. 3, 42-44. Online at http://lj.libraryjournal.com/2006/02/academic-libraries/raised-by-wolves.

Nixon, Robin. 2012. *Learning PHP, MySQL, JavaScript, and CSS: A Step-By-Step Guide to Creating Dynamic Website*, 2nd ed. Sebastopol, CA: O'Reilly.

Oracle. 2004-2012. *Oracle VM VirtualBox User Manual*, 42-55. http://dlc.sun.com.edgesuite.net/virtualbox/4.1.18/UserManual.pdf.

Society of American Archivists. 2009. "Orphan Works: Statement of Best Practices." http://www.archivists.org/standards/OWBP-V4.pdf.

O'Toole, James M. 1989. "On the Idea of Permanence." *American Archivist* 52, no. 1: 10-25. http://americanarchivist.org/doi/pdf/10.17723/aarc.52.1.3x85283576r43387.

Pearce-Moses, Richard. 2007. "Janus in Cyberspace: Archives on the Threshold of the Digital Era." *American Archivist* 70, 1: 13-22. http://americanarchivist.org/doi/pdf/10.17723/aarc.70.1.n7121165223j6t83.

Pearce-Moses, Richard. 2008. "Flatland to Virtual: Transcendence and the Digital Dimension." Paper presented at the Digital Initiative (Dig In) Conference, Albuquerque, NM, June 2008. http://home.comcast.net/~pearcemoses/papers/FlatlandToVirtual.pdf.

Pearce-Moses, Richard. 2014. "A Tool to Discovery Web Content for Archives and Libraries," *Archives in the Digital Era* [blog]. http://archivesinthedigitalera.blogspot.com.

Pearce-Moses, Richard, and Joanne Kaczmarek. 2005. "An Arizona Model for Preservation and Access of Web Documents," *DttP: Documents to the People* 33, no. 1. Preprint: http://home.comcast.net/~pearcemoses/papers/AzModel.pdf.

Pearce-Moses, Richard, and Susan E. Davis. 2008. *New Skills for the Digital Era*. Chicago: Society of American Archivists. http://www.archivists.org/publications/proceedings/NewSkillsForADigitalEra.pdf.

Petroski, Henry. 1999. *The Book on the Bookshelf*. New York: Alfred A. Knopf.

———. 1992. *The Pencil: A History of Design and Circumstance.* New York: Alfred A. Knopf.

"PREMIS: Preservation Metadata Maintenance Activity [website]." 2014. Washington, D.C.: Library of Congress. http://www.loc.gov/standards/premis/.

The Onion. 2013. "Print Dead at 1,803." vol. 49, no. 30. http://www.theonion.com/articles/print-dead-at-1803,33244.

Report on Current Recordkeeping Practices within the Federal Government. 2001. Prepared by SRA International for the National Archives and Records Administration. http://www.archives.gov/records-mgmt/faqs/pdf/report-on-recordkeeping-practices.pdf.

Sellen, Abigail J., and Richard H. R. Harper. 2002. *The Myth of the Paperless Office*. Cambridge, Mass.: MIT Press.

Society of American Archivists. "Directory of Archival Education." 2015. http://www2.archivists.org/dae.

Society of American Archivists. "Guidelines for a Graduate Program in Archival Studies." 2011. http://www2.archivists.org/gpas.

Stephenson, Neal. 1999. *In the Beginning was the Command Line.* New York: Avon Books. Online version at http://www.cryptonomicon.com/beginning.html.

Summers, Ed. 2014. "Fondz." https://github.com/edsu/fondz.

Trace, Ciaran B. 2011. "Beyond the Margin to the Mechanism: Computers, Materiality, and What It Means for Records to be 'Born Digital'." *Archivaria* 72: 5-27. http://journals.sfu.ca/archivar/index.php/archivaria/article/view/13358/14660.

"Victoria Jones v. Bremen High School District 228, case 1:08-cv-03548." Filed 16 October 2008. U.S. District Court for the Northern District of Illinois.

Vogt-O'Connor, Diane, ed. "The Information Ecosystem," special issue, *Cultural Resources Management,* vol. 21, no. 6. 1998. http://npshistory.com/newsletters/crm/crm-v21n6.pdf.

Waitzman, David. 1999. "RFC 2549: IP over Avian Carriers with Quality of Service" Internet Society, Network Working Group, 1999. http://www.faqs.org/rfcs/rfc2549.html.

Webb, Colin, David Pearson, and Paul Koerbin. 2013. "'Oh, you wanted us to preserve that?!' Statements of Preservation Intent for the National Library of Australia's Digital Collections," *D-Lib* 19, no. 1/2. http://www.dlib.org/dlib/january13/webb/01webb.html.

Yates, JoAnne. 1993. *Control through Communication.* Baltimore: Johns Hopkins Press.

Yeo, Geoffrey. 2007. "The Concepts of Record (1): Evidence, Information, and Persistent Representations." *American Archivist* 70, no. 2: 315-343. http://americanarchivist.org/doi/pdf/10.17723/aarc.70.2.u327764v1036756q.