"Sustainable Online Resources in the History of Modern Physics and Allied Sciences; Payoffs and Tradeoffs"

R. Joseph Anderson
Center for History of Physics
American Institute of Physics

Many of the speakers in today's symposium have discussed the future of archival automation. I'm going to be talking instead about the present and the past, in the hope that history will provide some insights into our own professional development and that past successes and failures may help us make wiser and better informed decisions in the future. I'll begin by describing the development of national and international library and archival data standards over the past forty-some years by the U.S. Library of Congress and the National Archives and a few other major international players. Then I'm going to discuss the work that the hundreds of academic and institutional archives in the U.S.--which hold the great bulk of science records in America--have accomplished in the past 20 years to automate information on their holdings.

My main point of reference will be my own repository, the Center for History of Physics at the American Institute of Physics, and our experience in creating two sustainable online databases—the International Catalog of Sources and the Physics History Finding Aids Website. Each represents a major, widely used resource in the history of modern physics, astronomy, geophysics, and allied fields. In terms of adopting computers and using them to catalog archival collections and, more recently, mount finding aids on the Web, our work has paralleled the efforts of the majority of American archives. That is, 1) we have depended on a few large library and archival repositories to create the systems and standards that we use; 2) we've generally stayed away from the cutting edge of technology but instead have waited for new applications to be tested by the bigger players; and 3) we have depended initially on a combination of funding from our parent organization and outside sources to support nearly all of our new computer applications.

This pattern is true of nearly all the academic and institutional archives that I'm familiar with in the United States. As I'll discuss a little more later, archives in the States and, I believe, in many other countries as well generally operate in a culture of scarcity. Again like most archives, we have occasionally adopted new systems that had to be replaced in a few years, but overall we have successfully converted our manual catalog and conventional paper-based finding aids to automated systems, made them accessible on the Web, and have sustained and expanded them over time. Automating our catalog and finding aids have involved payoffs and tradeoffs, and I will be telling you about some of both.

I want to emphasize that in one important respect our work to create our catalog and finding aid Websites is different from other archives. Each reflects our mission to help preserve and make known the history of modern physics and allied sciences as a whole in the United States and abroad, and not just report our own holdings. From its inception in the 1960s the Center has served as a collector and clearinghouse of information on archival records, manuscript collections, oral history interviews and other primary sources from throughout the U.S. By the early 1970s we began collecting information on primary sources in foreign repositories as well, creating the basis for our International Catalog of Sources for the History of Physics and Allied Sciences or ICOS as it exists today. Because the International Catalog contains records from more than 500 repositories worldwide, and our newer Physics History Finding Aids Website contains about 160 finding aids from 20 repositories and is expanding rapidly, these two automated systems are of international interest. They represent resources that are diverse, vital to doing research in our fields of interest, and in many cases not available in any other online systems.

The National Archives and the Manuscripts Division of the Library of Congress are the best known repositories of archival records and personal papers respectively in the U.S., and they certainly have the largest budgets and technical staffs. They recognized the importance of computers to both library and archival operations early on. By 1964-1965 the Library of Congress had created the original Machine Readable Catalog or MARC data structure standard for books, which has come to provide the data structure

standard for describing books and a little later archives nationally and internationally. By 1973 the Library of Congress developed a MARC standard for archival cataloging—called MARC Manuscripts format.[1] And in the 1970s the National Archives inaugurated a program that worked to help government agencies preserve permanently valuable electronic records.[2]

Computers, more than anything else, have changed the nature of how American archivists track and provide access to their collections, and as stated above the Library of Congress and the National Archives were fast to respond to the computer age. However, most academic and institutional archives in the U.S. were much slower in responding. And it is these smaller archives that hold the great majority of collections in our fields and other areas of science. While American academic and institutional archives are very diverse in terms of collections, staff size and other resources, they share some things in common. Most have limited financial resources in relation to their missions, and they rely to a very significant extent on outside grant funds, both public and private. This is especially true when it comes to new technological applications, which have significant start-up costs for hardware, software, and trained staff.

As a result most American archives didn't begin to have hands-on experience with computers until the early 1980s with the advent of relatively low-cost desktop microcomputers. Even then the majority of archives ignored the opportunity to begin automating their catalogs for a number of years. There are several reasons why repositories hesitated to develop computerized catalogs, and I'll mention the four that I think are the most important. The first is that archives, unlike many libraries, typically didn't have the money to invest in the staff time and large computers that were required to automate a sizeable catalog. Second, archives, again unlike libraries, didn't achieve a cost advantage by machine readable cataloging since they weren't able to use copy cataloging. The third is that the MARC Manuscripts standard wasn't well designed for cataloging archival collections; it was actually a slightly modified book cataloging standard that was best suited for individual rare documents. And the fourth reason is that through the 1970s most archivists took a rather casual attitude to cataloging. Unlike librarians, who standardized book cataloging rules early in the 20th century, archives

tended to develop their own in-house standards because they saw the catalog as only one means out of many for describing their collections. In fact, the knowledge that experienced archivists had of their collections was often considered a more important resource, along with written finding aids and collection guides, than the repository's catalog. Nonetheless, the development of machine readable cataloging in the 1960s and 1970s made archivists at the Library of Congress, the National Archives, and a few other large repositories aware of the need for nationally applicable descriptive standards. At the same time efforts were launched to create a better and more applicable version of the MARC Manuscripts format—one that would actually meet the needs of online archival cataloging.

Like most other archives, the Center for History of Physics kept both its own catalog as well as the International Catalog of Sources on a card file for many years. We included information on new ICOS records in our biannual newsletter and also published occasional subject guides such as *Source Materials for the Recent History of Astrophysics* (1971). We acquired our first computer, a small desktop microcomputer, in mid 1982. The new availability of relatively inexpensive stand-alone microcomputers at this time meant that a growing number of archives could afford a small computer that could be used to automate a variety of routine functions. Just as important, it gave many archivists their first hands-on experience with computers and an opportunity to begin thinking about the ways that automation could be used in archives.

Instead of confining use of our new microcomputer just to clerical functions, we soon began automating the ICOS card file in a small database. We added all of our own manuscript and oral history holdings by 1983 and the remaining ICOS entries by 1985. However, we continued to use our own loose in-house descriptive standards instead of the new and much improved MARC Archives and Manuscripts Control standard that was introduced in 1984-1985. Our first take at computerizing ICOS required relatively little outlay for hardware or software, but it did require a considerable investment in staff time. And the payoff was only moderate. We gained better in-house access and control of the International Catalog of Sources, but we were no closer to providing external access or meeting the increasingly important national standards.

The new MARC Archives and Manuscripts Control (MARC AMC) data structure standard provided for the descriptive needs of modern archival collections, but when it was introduced in 1984-1985 many archivists doubted that it would have much impact on how most repositories cataloged their collections. The new standard was effectively designed to create catalog records for all size collections, as opposed to the original MARC Manuscripts standard, which was really intended to catalog single items. However, adopting it would incur major costs in software and staff time and it would require that repositories learn new cataloging skills and redo their existing catalogs according to new national standards. All of this would result in one primary payoff--making their resources available online. Many archivists at the time thought that MARC AMC would be used by only a few of the larger, more prosperous academic and institutional archives.

Instead, recataloging archival collections according to the new MARC Archives and Manuscripts Control standard became very popular in the second half of the 1980s and the 1990s. Recataloging collections in MARC AMC, or retrospective conversion as it's called, and contributing them to one of the two national bibliographic databases, either OCLC or RLIN, came to be seen as one of the important criteria for archives to be seen as well managed and progressive, and it remains so today. It's interesting to try to understand why the recataloging of archival collections in MARC AMC became so popular. It was promoted and supported by several national organizations. The Society of American Archivists endorsed the new standards and held many sessions discussing the advantages of automated cataloging through the 1980s. And the Society began conducting a long-running series of workshops to train archivists in the new cataloging standard. The Library of Congress began publishing its National Union Catalog of Manuscript Collections online on RLIN in 1988, discontinuing the printed version, which meant that most archivists were exposed to and became familiar with an important automated archival catalog. The Library also published a guide to using the data content standard. Called *Archives, Personal Papers, and Manuscripts* or APPM for short, it remained the bible of archival catalogers until it was recently replaced *by Describing Archives; A Content Standard (DACS).* And most important, the National Endowment for

the Humanities, one of the primary government funding agencies for archives, began funding grants to both individual repositories and consortia to do retrospective conversion projects.[3]. It was the grants from NEH and some other funding agencies that encouraged many archives to submit proposals and invest some of their own funds in the expensive work of converting their existing catalogs to online MARC AMC standards.

I want to pause here and make clear that not all archives have adopted MARC AMC today and not all American archival collections are cataloged online, and this includes some very important repositories in physics and allied sciences. However, the reception of the new standard and of computerized cataloging was very strong in the American archival community. In a 1986 article, the author of *Archives, Personal Papers, and Manuscripts,* Steve Henson, said that MARC AMC "has the potential to change the lives of archivists forever . . . . [and he added that] contemplating the possibilities for information sharing, automated union catalogs, network building, and computerized management is enough to make most archivists positively giddy." By 1988 the OCLC and RLIN databases combined held approximately 150,000 catalog records for manuscript materials, and today the two utilities report combined holdings of a little over one million archival and manuscript records.[4]

Since an important part of the mission of the Center for History of Physics is to serve as a clearinghouse for information on physics, astronomy, and allied science collections held both at the Center and elsewhere, the prospect of joining and contributing to a national cataloging consortium was very attractive. However, it was the possibility of obtaining outside funding that allowed us to seriously plan to automate the International Catalog of Sources. And the support that we received over time represents three of the ways in which outside organizations supported archives like us in automating our catalogs using the MARC AMC data structure standard at the time. The first was the Historical Documents Inventory of the State of New York. The Center and AIP were located in New York State until 1993, and in the mid 1980s the state's Historical Documents Inventory began contributing the records of many in-state repositories, including the History Center's own collections, to RLIN using the new standard. However, the State inventory did not catalog records for all of our own collections, and it

would not catalog any collections at other repositories, which represents the most valuable component of ICOS.

The second and far more important source of support was the National Endowment for the Humanities. We applied for a grant from the Endowment in 1987 for $143,087 to verify, edit, and update our existing ICOS records to conform to MARC AMC standards; to convert this information to computer form; to conduct an international survey that would expand the database; and to enter all the old and new records onto RLIN. Our grant application was approved in 1988, and we began a project that was to create the International Catalog of Sources in its modern form. Like most large computer projects, it cost far more than we originally estimated and took far longer to complete in its initial form—ten years in all—than planned. And of course we had to change direction several times during the project, either in order to resolve problems or to accommodate changes in technology. Despite these obstacles, however, the project was successful and the end product was the creation of a major online resource for primary sources in the history of physics, astronomy, and allied fields. And ICOS became genuinely international in scope for the first time.

While we had gradually accumulated a few hundred ICOS records for collections in foreign repositories, nearly all European, by the late 1980s, the International Catalog of Sources was in fact primarily a resource for holdings in American archives. The National Endowment for the Humanities grant included plans to send survey letters to foreign archives, inquiring about collections in our fields. However, a third source of support, a grant from a private organization that funds cultural and educational projects, the Andrew Mellon Foundation, allowed us to contract with central repositories in 30 countries to conduct archival surveys and send us descriptions of physics and allied science collections in those nations. It also provided the money for the project director to travel extensively in Europe and Asia to conduct visits with archivists there. In addition to European countries, we were able to contract with a number of archives in Asia, Africa, and Latin America as well. At the same time, our own staff did a systematic survey of American repositories, which we've continued regularly since then. By the time most of the surveys were completed in 1993, we had obtained descriptions of about 950 new

collections in foreign archives, and we also received additional information on 340 foreign collections that were already in the catalog. It's interesting to note that the number of new foreign collections that we obtained was almost exactly the same as the number of new American collections that we acquired through the domestic survey that our own staff conducted.

Today the International Catalog of Sources contains a little over 8,000 records, and a little more than 20% of them are from archives outside the U.S., representing 36 different countries. While the foreign records are heavily weighted toward European and Anglophone countries—including the UK, Germany, Australia, Russia, France, Canada, Denmark, Poland, Sweden, Norway, Switzerland, and Italy—we also have records for smaller numbers of collections in other areas as well. For example, we have records for 23 collections in India, and smaller numbers in Israel, Brazil, Argentina, China and Mexico. Since the early 1990s we have continued to receive information on new foreign collections, although again these reports are heavily weighted toward European countries. One of my interests in participating in this Congress is to meet with archivists from other areas and encourage them to contribute information on holdings to the International Catalog of Sources.

I've been talking about the payoffs that our long-term ICOS retrospective conversion and survey project produced. Now I want to talk about the tradeoffs that we had to make. The most important was the staff time and expense involved. While we couldn't have created the modern version of the International Catalog of Sources without support from the New York State Historical Documents Survey and grants from the National Endowment for the Humanities and the Andrew Mellon Foundation, it also required a major contribution of funds and staff time from AIP and the History Center during the ten years that we were creating the new system. And today it continues to require a large, ongoing commitment of staff time and funds to maintain and expand it. As a rough estimate, I would say that conducting our ICOS survey of American repositories twice a year, following up on individual foreign scientists, cataloging new records, and maintaining and upgrading the computer software and hardware entails staff costs of about $60,000 dollars a year. In addition there are occasional one-time costs like

the new computer cataloging software that we purchased in 1999 for $40,000 (and which we'll need to replace in a couple years). Further, we pay an annual subscription to RLIN and a maintenance contract on our cataloging software package that together cost approximately $10,000 a year. So for an organization like ours, with a small operating budget, supporting the ongoing costs of ICOS is a very significant expense.

Another tradeoff is making computer choices based on what's available, what's affordable within our budget, and what people are willing to work with. As I mentioned earlier, we had originally planned to make the new International Catalog of Sources available on RLIN, which is the larger of the two international bibliographic utilities. We knew there was one significant drawback to this: both RLIN and the one other international bibliographic utility is a member-only, fee-for-service operation, which means that individual researchers probably wouldn't have personal access to it. However, it is available at many research libraries and archives, and staff there would do searches for researchers. Or researchers could ask us to do searches for them. However, we discovered another drawback during the course of the survey. We asked the repositories that reported collections to us for permission to upload their records to RLIN, and most didn't respond. We don't know whether this was mostly an oversight or if it represented a reluctance to upload information on their holdings to a proprietary, fee-for-service site, but the result was that we couldn't use RLIN as the pathway to make ICOS available to the research community.

As we completed the large backlog of survey cataloging through the mid 1990s, we considered and debated a number of solutions to the problem of making our growing and increasingly valuable resource generally available. The catalog had grown too big to publish in paper form economically. A microform or CD-ROM edition was a possibility, although either meant the catalog wouldn't be easy to expand and update. And at the time we weren't sure how generally available CD players were, especially at small libraries and archives. By the time we had completed most of the backlog of cataloging in 1997, a practicable solution came along in form of the World Wide Web and a free Web cataloging package call PDI-OPAC. An archivist at the South Carolina historical society had developed the software package on his own, and he was offering it free

initially to a limited number of archives in order to eventually begin marketing it. We took advantage of the offer and mounted all of ICOS plus our book catalog on the Web. We completed the work in November 1997, making the International Catalog of Sources available to anyone who has Internet access. However, the drawbacks of our free software soon became apparent. PDI-OPAC turned out to be an unstable database that crashed repeatedly, sometimes several times a week. Both History Center staff and users soon learned that they couldn't rely on the system, despite the good faith efforts of the archivist who created the software to troubleshoot the problems. It took us two years to find a more-or-less reliable system and obtain the $40,000 from our parent organization to purchase and install the new software.

Once we had the new system, called Horizon, up and running at the end of 1999, we were able to provide a fairly reliable connection to ICOS with only occasional crashes. But as usual, there were new tradeoffs. One was that PDI OPAC was housed on a server in our building and we could get easy access to it. The new Horizon server required a more powerful server that could only be situated and maintained at AIP's publishing site, which is located several hundred miles away from the History Center. This meant that it was difficult for us to access and service the machine, and Information Technology (IT) staff at the publishing facility understandably saw serving our needs as a distant second priority to the needs of publishing, which provides the Institute with its primary source of revenue. The other problem was that both PDI-OPAC and Horizon are deep databases that aren't accessible to search engines like Google and Yahoo, so researchers had to know about the International Catalog of Sources and find it on our Website in order to use it. Many veteran historians of physics and astronomy in the U.S. are familiar with the History Center, and at least some of them understood ICOS well enough to track it down. However, others did not, and it's much less likely that researchers from other countries or other areas of study would be aware of it. It's taken a long time to finally make ICOS available to Google and other search engines, and we finally achieved our goal early this year. Thanks to clever and inventive programming and trouble shooting by our associate historian and almost a year of fine turning, researchers can now find their way to ICOS records from any conventional search engine.

We estimate that 85% of researchers today enter the International Catalog of Sources by Google or other similar search engines.

I'm now going to discuss more briefly the Center's other international database of resources, the Physics History Finding Aids Website. And I will be briefer both because we have been working on it for a shorter period than the International Catalog of Sources--in this case only eight years, and because I'm running out of time. In addition the Physics History Finding Aids Website, or PHFAWS for short, is more international in prospect than in reality today, although we hope to begin adding a substantial number of foreign finding aids in the near future. We began work to develop the Finding Aids Website in 1997-1998 for four primary reasons. The first is that we had acquired about 700 finding aids for collections over the years from both American and foreign repositories. As you know, finding aids contain very detailed descriptions and inventories for archival collections. They are sometime hundreds of pages long, in contrast to catalog records that are very brief, one-or-so-page summaries of collections. Catalog records include only the name of the collection, a few lines of description, the dates, and the names of the most prominent people and subjects represented. While a catalog record might list the names of a dozen or so people represented prominently in a collection, a finding aid for the same collection may include the names of a thousand or more people. Making finding aids in physics and allied sciences available online for the first time would be a very valuable resource for researchers. The second reason is that archivists at University of California, Berkeley and elsewhere had developed and tested a new data structure standard, Encoded Archival Description or EAD, that allow archivists to mount finding aids on the web in a stable way. So again, as in the case of MARC AMC, a new and tested standard was available and was gaining general acceptance. The third reason is that adding finding aids to our Website was a natural extension of the International Catalog of Sources. Finally, and again a powerful motivator, the National Endowment for the Humanities was funding grants for EAD projects.

In 1997 and 1998 we began researching EAD requirements and sent three staff to Society of American Archivist-sponsored workshops or courses to learn the new standard. And because we are always concerned with including the records of other

organizations, we negotiated with nine other major science archives to join with us in a consortium and allow us to encode their most important physics/astronomy finding aids and mount them on our server. We also agreed to send them the computer files in case they eventually wanted to mount them on their own servers. The members of the consortium included us, the archives at Harvard, CalTech, MIT, and six other repositories.

At the same time we began drafting an application to the National Endowment for the Humanities to help fund the project. The proposal, which requested $78,000 in support, was submitted in 1998 and funded in early 1999. As a side note, you may remember that we had requested about twice this amount ten years earlier from the same agency for the ICOS project. We requested less for the EAD project because it was smaller in scale, but also because many of the traditional sources for archival funding in the U.S., including the Endowment, have suffered cutbacks and usually provide smaller grants as a result.

Once we obtained Endowment support, we began recruiting a full-time archivist to help our own staff mark up finding aids in EAD. In 1999 very few people had much hands-on experience with EAD, but we were fortunate in hiring a young archivist who had about a year's experience in one of the pioneer projects in the new standard. As soon as we began the project, we realized what had seemed possible to achieve was in fact going to be very difficult and maybe impossible. The biggest problem is that EAD provides a structure that finding aids need to conform to, but there has been no generally accepted standard for creating finding aids. Each of the ten members of the consortium used different standards, and the standards from the same archives would often change over time. This meant that our staff had to reorganize manually each of the finding aids to meet the general outlines of the implicit standard contained in EAD, and they also had to have sophisticated computer skills to manipulate the EAD program to meet our needs.

It quickly became obvious that our regular staff, with perhaps two weeks of training in Encoded Archival Description all told, did not have the skills to do the technical work. But then we realized how fortunate we were in the new archivist. He turned out to be a talented and self-taught programmer as well as a skilled user of EAD.

We turned most of the technical work over to him, and the rest of us took over project administration, working with the consortium members to obtain the promised finding aids, and other work. By dint of a great deal of work, by spending more of our own money than originally anticipated, and by extending the project for a year, we were able to meet our goals. By the end of the project we successfully marked up, mounted on our server and made available on the Web for the first time finding aids for seventy-some collections, including the papers of Richard Feynman, John Van Vleck, James Van Allen, and other seminal figures in the history of 20th century physics and astronomy. All of the finding aids in the new Physics History Finding Aids Website were cross-indexed and cross searchable.

By the end of the project we had also answered three of the questions that we had posed to ourselves as we were developing it. The first was whether online finding aids were a valuable tool for researchers. Our own evaluation and responses from independent scholars showed that they were. The other two questions were how much skill was required to do the work, and whether we could afford to continue to mark up finding aids from other archives and add them to our cross-indexed Website. We would now have to depend on our own resources alone to fund the work, since we wouldn't be able to get outside support from NEH or other funding agencies after the start-up phase The answer was that we couldn't do it on our own, without diverting very significant staff time to EAD work and seriously neglecting our other priorities. And the answer to skill levels is that EAD requires more than workshops or occasional short courses to learn adequately. So we knew that we couldn't continue to expand the Physics History Finding Aids Website by taking in and marking up other archives finding aids as we had during the Endowment-funded project.

By reorganizing our staff at the end of the project we were able to create a regular Automation Archivist position for the first time. The person in this position was responsible for trying to solve our EAD conundrum as well as dealing with other emerging technologies. By 2001 we had come up with a potential solution to the problem of expanding the Physics History Finding Aids Website. By then, more and more archives were marking up their own EAD finding aids, including a number of

repositories with important science collections. These were of course not cross-indexed and not searchable either on our Physics History Finding Aids Website or on any other one resource. But we learned that the Institute's powerful new search engine, Verity, could spider servers at other institutions, index the contents, and return the index to our servers.

We realized that by working with other repositories and indexing the finding aids for collections in physics and allied fields that they had mounted on their servers, we could continue to expand our Finding Aids Website and provide a service both to the archives that we worked with and to the research community. The hitch, however, was that achieving this would require difficult and time consuming computer programming that was beyond the skills of History Center staff. Instead we would have to depend on donated time by Information Technology staff, and since this was a low priority for AIP as a whole, it would in turn depend both on the extra time they had to work on it and by their continued interest in the project. This was a departure from our usual pattern of waiting until other organizations have developed and tested the software that we need and then adopting it as soon as it seems stable. However, we saw no other course in this case. It has in fact taken four years of off-and-on work by the Institute's IT staff and a series of unexpected glitches before we were finally able to complete the necessary programming and begin harvesting finding aids at other archives. We made the final breakthroughs early this year, and have now successfully harvested 40 finding aids from 6 repositories, bringing the total count of finding aids in the Physics History Finding Aids Website to 163, all cross indexed and available on the Web. We will continue to maintain and add to the Website on a continuing basis, sustaining it in the same way that we created the International Catalog of Sources as a permanent resource years earlier.

Before I turn to lessons learned from these two long-term projects and other automation work, I want to mention that when I accepted the invitation last year to speak here on the History Center's experience, we hadn't made the two breakthroughs that I've talked about: 1) making ICOS accessible to Google and other commercial search engines and 2) successfully harvesting finding aids to continue expanding the Physics History Finding Aids Website. It's a happy accident, building on long and sustained effort, that

we achieved both of these breakthroughs earlier this year. And of course now we're working on two new automation projects. One is to unite all of the Center's catalogs--the International Catalog of Sources, the Finding Aids Website and our catalogs of in-house photos and books--into one search box. The other is to begin scanning and putting on the Web the text of our large collection of oral history transcripts. I expect that both of these projects will be successful. And I also expect that they will take more time and money than we currently expect, despite the fact that we believe we're setting reasonable goals and timelines for ourselves.

Each of the projects that we have undertaken to make information on holdings in our field accessible to researchers has moved us to another access stage, and each has had payoffs and limits. In addition, each has competed with other activities that we might have focused on instead, and most have entailed a commitment to long-term costs. They have also played a major and often decisive role in shaping the nature of our program. Our experience in slowly developing a viable and growing suite of online international databases of information on resources in our fields has represented a continuing learning experience for us. I'm going to conclude by talking about some of the general lessons that we've gained over the past 25 years in automating information on holdings, and during the past 15 years in beginning to put the information online. Most of what we've done has been successful, and we've mostly been able to able to expand, update and sustain earlier systems. However, we've had a few failures and have occasionally had to redo work already done. All of our major projects have taken longer than anticipated and required resolving unanticipated challenges, and some of our experiences both in planning projects as well as implementing them may be of value to others.

1. The first lesson learned is that both the research community and the individual repository benefit when an archives makes their resources accessible online.
2. The second is that it's important to follow national and international standards in order to share information with others and to be able to update and migrate evolving systems.
3. The third is that archives operate in a culture of scarcity. There are a variety of reasons for this, but I believe that with few exceptions in the United States--and I

think elsewhere as well--archives typically have very restricted resources, almost always much less than libraries, which are their closest counterpart.

4. A fourth lesson is that outside funding sources, ranging from government agencies to private foundations to individuals, may sometimes be willing to fund new technological applications and start up costs, but they won't provide ongoing support. They are also less likely to support traditional core activities like processing and collecting because of the competition from new computer projects.
5. The fifth is that the more complex the information system, the more likely it is to break down, even after the initial bugs have been worked out.
6. And the sixth lesson, which I haven't touched on, is that people sometimes forget that there will be a transition in systems every five years or so and they underestimate the transition costs.

These six lessons break down into a few general principles. One is that making information about archival resources available online benefits both the contributing archives and researchers, and it's important that archives follow national standards in order to upgrade, sustain, and migrate their online systems. Another principle is that archives have inadequate financial resources, and computer projects compete with other core activities for scarce outside funds. The third principle is that computer projects are expensive to create in the first and also commit the archives to ongoing, often unanticipated expenses. And they play a very significant role in shaping a repository's program either for good or ill, depending on the choices made.

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[1] Lyn Martin, "Viewing the Field: A Literature Review and Survey of the Use of U.S. MARC AMC in U.S. Academic Archives," *American Archivist*, 57, 3 (Summer 1994): 483.

[2] Margaret O. Adams and Thomas Brown, "Myths and Realities About the 1960 Census." *Prologue*, 32, 4 (Winter 2000), 266-270.

[3] Robert P. Spindler, "Bearing The Standards: Reinventing the SAA Descriptive Standards Curriculum," (Revised version of a presentation before the Society of American Archivists, 1995Annual Meeting.)http://www.public.asu.edu/~spindler/SAA1995.DescriptiveStandardsCurriculum.webversion.htm

[4] Martin, "Viewing the Field, 483-484. Current statistics received from Tony Gonzalez, NUCMC, Library of Congress, 7/18/05: RLIN 770,395, OCLC 255,941