Enhancing E-Resources by Studying Users: The University of Rochester’s Analysis of Faculty Perspectives on an Institutional Repository

INTRODUCTION
As libraries have increased their use of such digital materials as e-journals, electronic theses and dissertations, and gray literature stored in digital repositories, they have sought new and better ways to make these materials findable and usable by students, faculty members, and other patrons. This has meant developing online tools, in addition to the library catalog, that make it possible to search large collections of e-resources, sort through and pare down long lists of “hits” to find the most appropriate ones, and then gain access to these materials in only a few “clicks.” It might seem that the requirements for these online tools would be so obvious that developers would never have to consult with librarians, let alone users, to build them successfully. However, experience shows that the best online tools depend on participation throughout the design and development process by a variety of people, including students and faculty members, librarians and library staff, interface designers, and software engineers.

In this chapter, we describe a design project that demonstrates how user input can lead to improved design and more effective use of e-resources. In this project, the University of Rochester’s River Campus Libraries collected information about faculty work practices in order to document obvious needs and reveal less apparent ones related to our new institutional repository. The mapping process we used to link raw data to requirements, and from there to specifications and solutions, provided a heuristic for problem solving and a structure for ensuring that our repository really did meet the needs of our faculty.

MAKING OUR INSTITUTIONAL REPOSITORY WORK
An institutional repository (IR) is an electronic system that captures, stores, and provides access to the digital work products of a community. Its main components are a repository of content, associated metadata, and a user interface. In the case of a university IR, success is an IR that meets both institutional and individual needs, filling the repository with searched and cited scholarly work of enduring value, serving as a showcase of the intellectual output of the university, and enhancing scholarly communication.1

In some ways, an IR is a simple extension of a university’s library. Both collect and preserve scholarship (the content), organize it (using metadata), and make it available to members of the university (through various interfaces).
However, adding an IR to a library’s suite of collections and services is not so simple. This has partly to do with the fact that libraries are currently in transition, having changed from the days of card catalogs, paper indices, print journals, and primarily paper collections. Some digital tools that started as time-saving options are now required components of library services. The replacement of card catalogs with online catalogs took years but is now complete in many libraries. However, the transition from legacy to digital systems is far from complete, and the library still houses vast amounts of physical material. The library model offers metaphors for IR design but does not serve as the IR’s model. In addition, connecting the IR to the library is not straightforward, due to the differences between them.

Libraries traditionally brought in works primarily from outside the university, mainly on paper, and made them available to faculty members. The academic library’s role was to buy the end products of the scholarly conversation, that is, books and journals. Now, libraries are also taking responsibility for making the work of the university’s own faculty available to an audience outside the university, usually in digital format. As they do this, libraries enter into the live, pre-publication conversation as never before. IRs support this by providing a way to store, organize, find, and deliver the university’s scholarly output, not just to members of the university but to anyone in the world with an Internet connection.

While libraries build their collections mainly through purchases of commercial publications, IRs are built by faculty members submitting their own work. In other words, librarians are dependent on the people who generate the content to make the deposits into the IRs, since they cannot just purchase the content as they would a published book. Indeed, the library could build an IR and then find that none of the faculty members deposit their content into it. In fact, this has been happening: faculty members have not rushed to take advantage of the new IRs that have been set up to preserve and disseminate their work.²

In the process of conducting research on prospective faculty users of our university’s IR, our mapping technique has helped us understand some of the complex reasons why faculty members have been so slow to put their work into established university IRs. These reasons include the mismatch between the language of librarians and the language of faculty members, and the complex relationship among the needs of faculty members, librarians, university administrators and others. Our pathway forward, as IR implementers, is to create an enhanced user experience on top of our existing IR system that is a better match with the expressed needs of all users. That is, our path is to understand what users really need to do and then to design e-resources to meet those needs.

WHAT USERS REALLY WANT
We began implementing an IR at the University of Rochester by selecting DSpace as our platform.³ Initiated through a partnership between the Massachusetts Institute of Technology Libraries and Hewlett-Packard, DSpace is an IR application that is being developed collaboratively by a large group of committed users. DSpace is just one open-source collaboration among big universities; another well-known one is Fedora.⁴ We chose DSpace because it offered us an opportunity to be part of the development process and bring our user-centered design methodology to bear on the emerging product.

Once we had completed initial installation, one of our librarians began to pitch the IR to faculty members using typical DSpace promotional language, shown in Figure 1.
DSpace Features and Benefits

- Large-scale, stable, managed long-term storage
- Support for a range of digital formats
- Visibility for research results
- Persistent network identifiers
- Flexible and simple submission process
- Search and delivery interface
- Digital preservation services

Figure 1. Typical Promotional Language

Meanwhile, we began a user study to collect the information we needed to customize the interface and enhance the IR so it would be more usable and interesting to our faculty. We thought the best way to collect this information would be by means of a work-practice study, that is a fine-grained, on-site study of individual researchers engaged in typical research practices. We took a team approach, involving a computer scientist, anthropologist, software engineer, graphic designer, and public service and catalog librarians. This team videotaped over two dozen faculty members in their work settings performing research tasks and showing us how they organize their physical and cyber workspaces.

We did not simply ask faculty what they wanted in terms of an institutional repository. Instead, we tried to ask questions about their research and about scholarly communication in general. We also probed their use of digital tools in their work and their use of the library.

We transcribed all observational sessions and analyzed the transcripts and video to yield a range of findings, from lists of faculty needs and storyboards of the faculty research process to models of faculty preferences and perspectives. For example, we learned that

- Faculty members are passionate about their research
- They want digital tools that work but they do not care how they work;
- Placing their work in an IR is only of value to faculty members if other scholars find it there, use it, and cite it

As Table 1 shows, faculty members have a very different perspective on DSpace than other users and stakeholders. Indeed, not just faculty members, but all types of users and stakeholders have their own distinctive and different needs and perspectives.
<table>
<thead>
<tr>
<th>Type of User or Stakeholder</th>
<th>Main Interests in Institutional Repository</th>
</tr>
</thead>
</table>
| University administrators        | Showcase university’s scholarly output  
|                                  | Contain the expense of scholarly journals                                       |
| Individual faculty members      | Find resources to use in one’s work  
|                                  | Keep one’s work secure and accessible  
|                                  | Disseminate one’s work                                                          |
| Software developers             | Make IR work  
|                                  | Make good on all claims of IR functionality                                      |
| Librarians                      | Develop, catalog, and preserve collections                                      
|                                  | Help faculty and students find resources                                         |
| Scholars outside the university  | Get access to scholarly work                                                     |

Table 1. Examples of IR Users and Their Different Interests

Sometimes, these different interests have led to disabling mismatches between IRs and users. The more we learned about our IR, the more we realized that it was organized to suit the purposes of nonfaculty users and was described in nonfaculty language. Owing to this, most faculty members looking at the IR failed to see how it could benefit them. Here are a few specifics:

- The language of the IR, shown in Figure 1, did not correspond to the language that faculty members used in our interviews with them. For example, while we saw that almost all faculty members had problems with broken links as they searched for resources on the web, only a few mentioned this as a problem, and only one used a phrase that even approached “persistent network identifiers.” This was a relatively easy problem to correct, but until we learned how to talk to faculty in their own terms, we missed many opportunities to recruit them to IR use.

- The organization of DSpace into departmental communities and subject area collections does not correspond to the spontaneous, shifting networks of scholars engaged in related projects. DSpace is organized to present the content of the institution as a whole and thus to meet institutional needs. We think we have found a partial solution. In addition to the community/collection hierarchy of DSpace, we are building “Researcher Pages” (Fig. 2) so that faculty can organize their own work on searchable pages and include links to the sites of other people in their networks.

In order to ensure that faculty members invest their time and energy in using an IR, we must both speak their language and directly address their needs with the technology. We are using our mapping technique to translate their needs into technical specifications and ensure that we fully support those solutions.
This sample Researcher Page includes a photo and an area for contact information and professional interests. On the left side, faculty can present their work using a hierarchy of folders and include links to other sites and related content.

Figure 2. Researcher Page Enhancement

COMPLEXITIES OF IMPLEMENTATION

There is a dilemma with DSpace. Since it addresses institutional requirements so well, institutions across the country have deployed this IR. However, because of the mismatches described in the previous section, faculty members are not putting as much content into DSpace as the institutions might have expected.

Further complicating the picture, our research on faculty members has revealed a range of needs for web-based services to support research activities, some of which are supported by DSpace and others of which are not, as shown in Table 2.
<table>
<thead>
<tr>
<th>Faculty Need</th>
<th>Technology Enabler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make their own work available to others</td>
<td>DSpace</td>
</tr>
<tr>
<td>Preserve digital items</td>
<td>DSpace</td>
</tr>
<tr>
<td>Ensure that documents are persistently viewable or usable</td>
<td>DSpace</td>
</tr>
<tr>
<td>Have someone else take responsibility for the server</td>
<td>DSpace</td>
</tr>
<tr>
<td>Make digital items permanently accessible</td>
<td>DSpace</td>
</tr>
<tr>
<td>Work with co-authors</td>
<td>Document authoring and versioning system</td>
</tr>
<tr>
<td>Work from different computers and locations, both Mac and PC</td>
<td>Web-based document authoring and versioning system</td>
</tr>
<tr>
<td>Have easy access to other people’s work</td>
<td>Web-based repository organized by the researcher with search tools and permission control</td>
</tr>
<tr>
<td>Keep up in their fields</td>
<td>Improved search tools and general adoption of DSpace to improve the accessibility of all scholarship</td>
</tr>
<tr>
<td>Organize their materials according to their own scheme</td>
<td>Individual control of navigation structure and permissions for Web access of their work</td>
</tr>
<tr>
<td>Control ownership, security, and access</td>
<td>DSpace and document management permissions with adequate granularity and enhanced user interface</td>
</tr>
<tr>
<td>Be sure not to violate copyright issues</td>
<td>DSpace enhancements and librarian support</td>
</tr>
<tr>
<td>Keep everything related to computers easy and flawless</td>
<td>User-centered design</td>
</tr>
<tr>
<td>Reduce chaos or at least not add to it</td>
<td>User-centered design</td>
</tr>
<tr>
<td>Not be any busier</td>
<td>User-centered design</td>
</tr>
</tbody>
</table>

Table 2. Faculty Needs and Technology Solutions
The simple listing of needs revealed that while the IR was meeting some faculty needs, it was not necessarily supporting their greatest needs or those that came earlier in the research process. That is, faculty members need to do their writing, alone or with co-authors, often going through many revisions, before they are ready to archive or publish it. We realized that the IR would be a greater success if we offered faculty members a system for managing the authoring process, especially if it easily led into the self-archiving and self-publishing features of the IR.

We also started to understand why even faculty members whose completed work seemed perfect for the IR were not depositing it. One of the reasons was that they did not have reason to believe that anyone else would find, use, or cite it. The solution to this problem, we believed, would be to tightly couple the act of depositing content into the repository with the rewards of presenting that work to colleagues. We designed our Researcher Page to do this by providing faculty members with a single, user-friendly interface for depositing and showcasing their work. We believe that this enhancement, which attends to the faculty need to present their own work to their colleagues, will motivate faculty to use DSpace and deposit their work.

As we identified and examined more and more of these needs, we discovered that we could trace out the way they did or did not connect to specific bullets of the DSpace promotional language (Figure 1). In many cases, faculty needs did map to DSpace features, but DSpace features were only a partial solution to the faculty need. In other cases, the DSpace promotional bullets referred to DSpace features that the product alone could not deliver.

At issue is the importance of collecting and then rigorously mining the data in order to bring all needs – not just obvious needs – to the surface. Once we understand the full range of needs, we can design or retrofit e-resources to meet those needs. Furthermore, we want to be sure both that our solutions meet real needs and that our solutions are combined with necessary services and supports and are configured to be efficient and effective. Thus, we need a tool to map from user needs to solutions and back again.

**ADDING MAPPING TO OUR TOOLKIT**

We have worked with so many faculty members and collected so much data that we have developed a need for a tool to manage, represent, and work with the data. The tool that we have used most successfully is a simple set of maps that connect all the data and ideas around each category of user needs that we find.

Each map traces a logical path from user-stated needs to fully supported technology solutions. We make one map for each general kind of user need, and we include a set of user quotes in the map to maintain access to the users’ own language. We analyze these quotes and distill a short list of needs that are now stated in the language we use in the project. After that, we brainstorm and define the system specifications that we think will address those needs and the technology solutions that could bring those enablers to our users. Finally, we map out all the forms of support that our technology solutions would require in order to work properly.

In order to understand how our mapping technique works, it helps to consider the relationships that exist among people and the connections that people have to their tools and objects. In our current example, we are most interested in faculty relationships and connections, as shown in Tables 3 and 4.

University faculty work within an ongoing scholarly conversation, engaging with colleagues, students, librarians, and others in order to learn more and say more about the topics and issues...
that matter to them. If our IR can provide digital tools in support of faculty relationships and work connections, then our IR will succeed. At the same time, the goals of librarianship – collection, preservation, organization, and access – will be achieved. Our mapping exercises are guiding us to technical and process solutions that will support our faculty in just this way. In the following section, we give an example of one of our maps to demonstrate the power of this simple tool.

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty ←→ colleagues</td>
<td>Collaborate, share data</td>
</tr>
<tr>
<td>Faculty ←→ librarians</td>
<td>Get research and teaching support</td>
</tr>
<tr>
<td>Faculty ←→ departmental and</td>
<td>Develop curriculum, provide service to the</td>
</tr>
<tr>
<td>institutional administrators</td>
<td>institution, advance</td>
</tr>
<tr>
<td>Faculty ←→ students</td>
<td>Teach, advise</td>
</tr>
</tbody>
</table>

Table 3. Some Faculty Relationships

<table>
<thead>
<tr>
<th>Connection</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty ←→ artifacts of topic</td>
<td>Collect, create, and study quilts, audio tapes, images, code, fieldnotes, and so on</td>
</tr>
<tr>
<td>Faculty ←→ data</td>
<td>Collect, share, generate, and manipulate data</td>
</tr>
<tr>
<td>Faculty ←→ repositories</td>
<td>Disseminate own work quickly, for example through arXiv.org; get feedback and credit for original work</td>
</tr>
<tr>
<td>Faculty ←→ journals, books</td>
<td>Share own work; learn about the work of others</td>
</tr>
</tbody>
</table>

Table 4. Some Faculty Connections

**AN EXAMPLE OF MAPPING**

In this section, we follow a thin path from raw data (a few actual user statements), through analysis, to solutions. We provide this example in order to illustrate our mapping process in use. We hope to show how a particular e-resource, our repository, benefits from collection, analysis, and use of information about the people who will actually use it.

We were initially motivated to map user needs to DSpace features to see if the exercise would reveal the reasons why faculty were not interested in the IR. In this example, we will show part of that mapping by focusing on a portion of the user needs that are related to finding archived material. As we work through this example, we will be looking at one particular DSpace feature – persistent network identifiers – to see where it emerges in the mapping process, that is, to see how closely this feature maps to articulated user needs.
We were also concerned about backing up the claims we made for DSpace. That is, when we say that DSpace “offers persistent network identifiers” what really makes that happen? Users might assume that persistent network identifiers are somehow part of DSpace, that they are just coded into the IR in some way. The system analyst and software engineer know that this is not true, of course. However, even our technical people find it essential to map out all the supports that are necessary for a system to work or for a feature to be offered in good faith. In our example, therefore, and by way of illustration, we trace out the necessary supports related to persistent network identifiers.

In addition, the more we learned about faculty needs, the more we wanted to create the big system picture of how we could meet those needs. Indeed, we began to see that meeting even a few of the most important faculty needs would likely increase faculty use of the IR. Mapping was thus our tool for identifying the specifications of the whole system. Here, we include the specifications related just to our small, focused example.

When we use our mapping tool, we start with the transcripts of sessions in which users have talked about what they are doing as they use their digital tools or conduct research. We extract user statements that relate to a particular category of need, usually having several pages of excerpts for each theme. In our example, we start with four brief excerpts from four separate interviews for illustrative purposes (Figure 4).

![User Statements on Finding Archived Material](image)

*User #1:* My first class this semester. [Clicking, typing:] I need to open that. Um, my first class this semester I did a PowerPoint presentation of pieces [clicking mouse] that I had not done that before, so I’ve taken [searching for document]

*User #2:* Yeah, but it’s not going to work. [Looking for document, extensive mumbling, typing] Let me think for a second. [Mumbling, typing] I think I had it, I… [Trails off]

*User #3:* If DSpace were really there, really preserving the URLs, then we might choose to set these links to points in DSpace, and that way we could actually have our server be mobile and changeable and yet have the URLs in DSpace be fixed.

*User #4:* Addresses would be fixed, right, so then I could say that I put a data file in there, so then people could go to DSpace right from my webpage if I had that URL in there.

Figure 3. Mapping Example Step 1

Once we have compiled user statements, our anthropologist analyzes them and works with an interdisciplinary team (computer scientist, software engineer, graphic designer, librarian) to identify the underlying needs. Figure 4 lists the analyzed needs related to finding archived
material. We use IT language when we list the analyzed needs that underlie the users’ own statements.

![Analyzed User Needs for Finding Archived Material](image)

- Make own work available to others
- Have someone else take responsibility for the server
- Make digital items permanently accessible
- Have easy access to other people’s work
- Reduce chaos or at least not add to it

**Figure 4. Mapping Example Step 2a**

We can see that the needs that underlie faculty statements extend far into faculty webs of relationships and connections. Meeting these needs will enable professional relationships; that is, they will support the context of scholarly work. By attending to these relationships, we build not just a usable interface but also a social interface that supports cooperative work. Figure 5 shows a few of the relationships and connections that are relevant in our example.

![Affected User Relationships and Connections for Finding Archived Material](image)

- Faculty ↔ colleagues
- Faculty ↔ librarians
- Faculty ↔ artifacts of topic
- Faculty ↔ data

**Figure 5. Mapping Example Step 2b**

Next, the interdisciplinary team brainstorms a list of everything it would take to meet the analyzed needs. Normally, a map would include everything that relates to all analyzed needs. However, in this example, we will treat only one need: “make digital items permanently accessible.” Figure 6 lists all the specifications we have identified in relation to this need.
System Specifications for Making Digital Items Permanently Accessible

- Provide a physical storage system that is managed to include standard operating procedures such as backup, mirroring, refreshing media, and disaster recovery.
- Ensure that a storage area will remain available and stable forever
- Assign a globally unique identifier to each item that will never change
- Provide access to items via the Web
- Provide a mechanism to indicate if files have been modified
- Provide a mechanism to ensure that specific file formats can be rendered the same way in the future as they can be rendered today

Figure 6. Mapping Example Step 3

In the next step, the system designer leads the team through a rigorous comparison of products and selects those that meet system specifications. Again, in our example, we are only following the threads related to “making digital items permanently accessible” (see Figure 7).

Technology Solution(s) for Making Digital Items Permanently Accessible

- DSpace
- Persistent Network Identifier Service (CNRI Handle System)
- Internet

Figure 7. Mapping Example Step 4

Finally, our computer scientist, software engineer, and systems people drill down to identify everything it would take to make our technology solution(s) work. At this stage, we have left the realm of pure technology. Figure 8 includes hardware and software, of course, but also the full range of resources required to make even the best hardware and software work. In other words, this is the place to include the dollars, person-hours, expertise, and procedural care that support system success.
In this mapping example, we wanted to see how “persistent network identifiers,” one of the bulleted DSpace features, related to user needs. To do this, we explored part of a category of user needs we called “making digital items permanently accessible.” In doing so, we gained greater understanding of our faculty’s lack of interest in the IR. Conversely, we discovered something about what it would take to make this e-resource workable and valuable to faculty members.

Our map shows that persistent network identifiers do not emerge until step 4, deep into the map and nowhere near user needs, whether stated in user or technical terms. In other words, we are touting a DSpace “feature” that does not capture the attention of users.

This particular example points to the more general problem that arises in implementing archives and other e-resources when we fail to differentiate among user needs, system features, system specifications, and necessary supports. Persistent network identifiers are a necessary support, dependent on other providers to make them work. When we differentiate between a user need and a necessary support, we can speak to real user needs in user language (see Figure 9). Differentiating among needs, features, specifications, and supports also allows us to develop a list of system specifications that covers the full range of user needs, or that portion of user needs that we can realistically address at one time. It not only helps us see the difference between IR features that are represented as part of the software design but also those that are really dependent on careful maintenance, ongoing enhancement and innovation, and permanent institutional resource commitments. Finally, mapping provides us with a fuller view of everything it will really take to make the system work, including services that are provided from outside the system itself.
Top Revised DSpace Features and Benefits

- This is all about your research: storing it safely and sharing it if you want to
- You can store items in DSpace permanently
- Your archived stuff is searchable through Google
- The DSpace submission process is far easier than posting documents to your personal or departmental website and you don’t have to worry about backups
- You can give colleagues a URL to your item that will always work

Figure 9. Revised List of DSpace Features and Benefits

For our own purposes, mapping has helped us see how to move beyond our Researcher Page to the design and development of an authoring environment for IR users. We conceive a large system, of which the IR is one part, to support the full life cycle of the faculty writing and publishing process. This system will support the professional research context and the ongoing scholarly conversation, making it easier for our faculty to share their work with co-authors at the writing stage and with all others upon completion.

CONCLUSION

In our work, we have discovered how important it is to observe actual user behavior and align our technology to genuine user needs. We have developed a tool to help us do this by mapping user needs to specifications, technology solutions, and necessary supports.

While this chapter revolves around a particular application of work-practice study, participatory design, and mapping, we see the value of user research and mapping beyond this one case. When improving metasearch or other e-resource related tools, research on faculty work practices would be invaluable. For example, fine-grained observation and interviewing of faculty members as they conduct research may reveal such practices as tasking students or assistants with this work, searching personal Web pages for citations, or a preference for certain types of databases. Such studies will certainly reveal the “workarounds” that faculty members use and that reveal both the limitations of their current tools and the ways that they would prefer to work. Actual research findings will point to particular solutions that might not have been anticipated and that will certainly work better than tools based on unquestioned assumptions.

Mapping has also shown us a pathway forward for the library as its use of e-resources continues to increase. Digital technology is now necessary for cataloging the library’s resources and then finding them again, and it is often the preferred way to use those resources. Furthermore, digital systems are now preferred for archiving and publishing scholarly work. As digital technologies become even more important in scholarly work and communication, libraries will play a greater role in providing for a fuller range of faculty technology needs. We believe that identifying the needs through work-practice studies and then mapping needs to a range of potential solutions will increase our success in meeting them.
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