Assessing the Research Practices of Civil & Environmental Engineering Researchers at the University of Wisconsin-Madison: An Ithaka S+R Local Report

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Introduction

In Fall 2017-Spring 2018**,** the University of Wisconsin-Madison participated in Ithaka S+R's 'Supporting Civil and Environmental Engineering Scholars' research study, along with nine peer institutions in North America. For this project, sponsored by ACSE (American Society of Civil Engineers), local teams comprised of librarians at participating institutions, conducted interviews that considered the research needs of civil and environmental engineering faculty. With the goal of developing recommendations toward libraries supporting these researchers' work, these teams collected qualitative data from researchers with the intent of both developing a local report and submitting the data to Ithaka S+R, a not-for-profit service specializing in strategic guidance, research, and publications for academic and cultural communities, for analysis and publication in a final capstone report ("Research Support Services | Ithaka S+R," n.d.).

This report covers four basic themes identified in the study: *Interdisciplinarity, Research, and Collaboration*; *Finding and Managing Information*; *Working with Data*; and *Publishing*. Sections on each of these are preceded by background information about the study and followed by a *Recommendations* section that lists ways in which library staff and services may address some of the needs expressed within these four themes.

Civil & Environmental Engineering at the UW

Dating back to 1857, the Civil & Environmental Engineering department at the University of Wisconsin-Madison is one of nine departments within the College of Engineering. It includes 31 faculty members, with 41 additional researchers listed as adjuncts or faculty affiliates from other departments or colleges. Currently, approximately 600 undergraduate and 150 graduate students are enrolled in programs in this department, which offers two bachelor's degrees, four master's degrees (including an online master), and two doctoral degrees in Civil and Environmental Engineering and Geological Engineering ("About - College of Engineering - University of Wisconsin-Madison," n.d.).

Broad research areas include the following:

- construction engineering and management
- environmental engineering and science

- geological engineering
- structural engineering
- transportation engineering
- materials for constructed facilities
- water resources engineering and science
- environmental chemistry and technology ("Academics - College of Engineering - University of Wisconsin-Madison," n.d.)

Faculty interviewed in this study represent six of the eight research areas:

- environmental engineering and science
- structural engineering
- transportation engineering
- materials for constructed facilities
- water resources engineering and science
- environmental chemistry and technology

As one participant explained, however, "Most civil and environmental engineering departments are like this: There's the dry side. So there's the side that makes buildings and roads and, you know, things like that. And then there's the wet side . . ." Rather than accounting for every departmental research area or generalizing too broadly, this report reflects this civil-dry/wet-environmental dichotomy, as the informal divide sometimes manifests in slightly different research practices, although not consistently.

Participants

Between January 16 and February 23, 2018, the local team conducted semi-structured interviews with eight faculty researchers from the Civil and Environmental Engineering department of the UW College of Engineering[1]. Three participants work broadly in civil engineering (or "dry

[1] The local team completed a two-day methods workshop with Ithaka S+R in October 2017. Participants were asked to sign informed consent forms approved through campus IRB. Ithaka S+R designed the interview questions; however, local team members were encouraged to modify questions and add clarifying follow-ups as needed. Interviewers digitally recorded all interviews, which were then transcribed by an external service. The team then coded and analyzed all interviews, identified themes, and anonymized as needed.

side") and five work broadly in environmental engineering (or "wet side"). Four participants are full professors with varying additional departmental titles, and four are assistant professors[2].

Researchers interviewed defined their primary research methods as follows:

Civil Engineering Researchers

- lab-based experimental methods, with numerical techniques and digital imaging, physical simulations
- computer simulations and some experiments
- mostly computers and low level equipment, applied research, observational and human based simulation, some product discovery/creation

Environmental Engineering Researchers

- almost exclusively computational
- mostly field observations
- mostly lab work, analytical chemistry, mass spectrometry instruments
- wet lab, work with solid phase analytical instrumentation
- wet chemistry, microbial culturing, identifying what microorganisms are doing

Interdisciplinarity, Research, and Collaboration

Of the three participants on the civil or "dry" side, one researcher identified his work as concerned chiefly with applied use of materials, focusing on cement and hazardous materials. He collaborates regularly with mechanical and chemical engineers due to shared specialization in process design, as well as experts on characterization and synthesis in material science, economists, and life cycle analysts. This work sometimes extends beyond the academy and into collaborations with concrete manufacturers, chemical companies, and large corporations.

[2] Participants were recruited via email starting on October 30, 2017. On November 20, 2017, the recruitment effort was expanded beyond faculty within the Civil and Environmental Engineering department to faculty affiliates listed on the department website; however, none of these faculty members responded. This study was limited to tenure-track faculty or personnel for whom research is part of their work; graduate students, adjunct faculty, extension faculty, and emeritus professors were not included.

Two civil or “dry” side researchers identified their work as transportation-based. Transportation research is further divided into two parts, as one researcher explained:

> *There is what's called a soft, which looks at traffic modeling and the transport from a traffic operations point of view. You know, traffic lights, congestions, number of lanes in the highways, and the planning side of it. And then the other side looks at the hard transportation sector, which is really building the highways and the bridges from the different layers, from the ground, up, to what you drive on, which is the paved road.*

One researcher interviewed focuses on highway materials and other “materials for constructed facilities, or for the built environment.” Because this research often concerns environmental issues, including air pollution from the production and construction of roads, there is significant cross-disciplinarity with environmental engineering, chemical engineering, and chemistry. It also involves collaborations with testing labs in Wisconsin, road construction contractors, and researchers at other institutions internationally.

The other participant with a transportation focus specializes in traffic operations and safety, with an emphasis on human factors, and is conducting research on autonomous vehicles. The latter, in particular, is a driver of interdisciplinary research:

> *it’s broad because when you think of how the safety and operations of an autonomous transportation system are going to interact, it really involves so many different things . . . it is not just a driver in a car anymore. It’s a car that’s interacting, communicating with the environment . . . And it’s, you know, across all the disciplines in the departments of the college and–it really involves almost everybody on campus.*

Primary collaborators on campus are in mechanical and industrial engineering, as well as computer science and the medical school. Externally, the researcher’s group works with the Federal Highway Administration, the Wisconsin Department of Transportation, and local municipalities, as well as within a research consortium dedicated to simulation-based traffic safety research.

On the environmental or “wet” side, researcher areas include water resource systems and wastewater treatment, air pollution, and the aquatic chemistry and levels of mineral content in drinking water. As with their colleagues on the civil side, these researchers emphasized working across disciplines, some indicating that this interdisciplinarity goes beyond collaboration.

“I'm an engineer. But I think the engineers think I'm a chemist,” reported one researcher, who uses analytical chemistry techniques to study “messy” environmental systems. “But the chemists think I'm a little too applied. So, I'm sort of at the cross-section of those two.”

A researcher who studies the causes and impacts of air pollution, claimed similar disciplinary overlap. “It's a subarea of environmental engineering,” he said, “But it's also much more interdisciplinary than, say, traditional environmental engineering. Environmental engineering, typically you think of like water and soil. There's often people like me in chemical engineering and mechanical engineering, in the School of Public Health, and chemistry.”

Nearly all researchers on the environmental side mentioned chemistry, chemical engineering, or biochemistry as a highly significant area of crossover or collaboration.

Some researchers explained their collaborations as a means of geographic necessity. “A lot of our research is observations around the world,” a researcher in air quality explained. “So if we're making measurements in Iran, we'll be working with people there. If we're doing stuff in China or India or Africa, we almost always have local collaborators.

Other collaborations come out of a need for equipment or expertise. A water quality researcher mentioned the need for an expensive mass spectrometer, which necessitates collaboration with the medical school where the instrument is housed. A researcher in biogeochemistry regularly uses solid phase analytical instrumentation located in the Department of Geology and the Materials Science Resource Center on campus, as well as equipment only found in billion dollar national labs.

Most participants mentioned students as important collaborators, with their graduate student advisees conducting research and offering technical support, but did not indicate librarians or other information technologists as key collaborators in their work. Library interactions described involved retrieving hard-to-find articles and making remote resources available.

Connecting with Colleagues Beyond the UW and Keeping Up with Trends

All eight interviewees mentioned conferences, workshops, or meetings as important ways of connecting with colleagues at other institutions and following trends. One reported that, while he does not travel to many conferences and workshops himself, he frequently sends students, and they initiate conversations on his behalf. Another researcher said that he does not attend conferences often, but goes to many workshops and travels often for collaborations.

Three researchers specified reading journals as another means of keeping up, with one adding that serving as a reviewer for scholarly journals is particularly valuable for keeping up with trends and colleagues. Only two researchers said that they use social media tools in this capacity.

Challenges in Collaboration

Collaborative challenges reported did not break down along civil/environmental research areas.

Some common collaborative challenges cited by the researchers involve international collaboration, primarily relating to common access to data and publications, as well as standardization.

> *. . . it's easy for me who's sitting at a premiere university like this [where] I can basically find any article I want, right? But some of my partners . . . particularly international partners, that's not the case, right? And so, if there were ways that we could make . . . our publications readily available as opposed to sending them a link and saying 'that's where it is' . . . sometimes . . . I do end up sending a pdf of the article to them, you know, from myself or an earlier draft of it, right? So that they can get that information. But to have the actual publication available to them would be ideal.*

Different models of standardization can also be a barrier to collaborating internationally:

> *We have also sponsored projects that are being—the results are being applied internationally, so they ask us to conduct some of the tests and evaluation methods that*

> *follow standards that are not produced in the U.S. and it's very challenging to get these documents and get them to be applied in our research.*

Other respondents focused on more local factors in collaboration. The University of Wisconsin-Madison is a highly decentralized campus, and some faculty in the Civil & Environmental Engineering Department have offices or labs in locations removed from the majority of campus engineering buildings.

> *You know, especially, so much of it still relies on running into your colleague in the hallway, and I think that's great, but I think we also . . . have a huge campus with a diverse faculty. And the program I'm in, in particular, the program most of my graduate students are in, environmental chemistry, is a bit odd, because while it's technically part of the civil and environmental engineering department, it's also a multi-disciplinary graduate program with faculty from several different departments that we have. . . . And so, by default, you don't see all of your peers, you know, in the program every day.*

Some suggestions from various researchers to improve local collaboration include the following:

- an internal database of people and their respective expertise, either across campus or across discipline, would be helpful in finding local collaborators
- better teleconferencing equipment and infrastructure
- training on collaborative software (e.g., Google Slides, Google Sheets) so that all parties can choose the best tools for a project and use them consistently
- a campus teleportation system

Finding and Managing Information

Interviewed researchers displayed slightly differing habits and challenges discovering and managing information based on disciplinary focus (civil vs. environmental engineering).

Types of Information Used

Civil and environmental engineers both report peer-reviewed articles as their predominant information resource. One researcher estimated that peer-reviewed articles constitute 95% of the external information sources needed to do her research.

Some environmental engineers mentioned pre-prints as a potential growth area in their respective areas of expertise:

> *These bioarchives are becoming more popular, so sometimes you get—you get preprints that way. I use Research Gate and if there is some new information that—there's information that something of interest came out but it's not yet published, through Research Gate I can request preprints, and that's usually very effective.*
>
> *So the American Chemical Society, is kind of my major professional society, has just started a pre-print program and server. And so I think—I wouldn't be surprised to see them take off in environmental chemistry in the near future.*

A mix of civil and environmental engineering researchers mentioned technical reports, standards, and books as useful resources, as well.

Information Discovery

Environmental engineers displayed a slight preference for using library subscription resources for resource discovery over their civil engineer peers. Four environmental engineering researchers listed Web of Science/Knowledge by name as a much-used discovery resource, often in combination with non-subscription online resources.

When civil engineering researchers do use library discovery resources, it tends to be indirectly or when other avenues fail:

> *[We find refereed journal presentations and conference presentations] mostly on the internet, and, if we cannot find it, then we go through the library to order a document or a journal or some published reports.*

A civil engineer who specializes in traffic safety reported using the free online TRID (Transportation Research International Documentation) database to discover most information, and another civil engineering researcher reported exclusive use of Google Scholar as a discovery tool for scholarly articles.[3]

[3] It was not made clear whether the researcher is aware that access to articles discovered in Google Scholar is library subscription-based.

No researchers mentioned library subscription databases other than Web of Science/Web of Knowledge, although some acknowledged librarians and interlibrary loan as helpful in finding elusive sources.

> *Every once in a while, like I said, there's an old paper or some weird journal I can't find. But I can't think of any time—the library's always been able to track it down.*
>
> *If it is not in the repository or the Web of Knowledge, the library has a pretty good service to find things for you and send it to you. . . . So, that's—that's pretty great.*
>
> *[We find refereed journal papers and conference proceedings] mostly on the internet and if we cannot find it, then we go through the library to order a document or a journal or some published reports.*

Managing Information and Citation Management

Information management habits for the researchers did not break down along civil or environmental focus. Personal use of citation managers varied significantly, as did adoption of shared citation managers across labs and among students. Nonetheless, many participants discussed information management and citation manager usage in a group context, some stressing the difficulty in achieving consistency.

Approximately half of the researchers interviewed use at least one citation manager to organize their information. One of these researchers uses Zotero exclusively and did not indicate whether this usage extends to students or research group. Other citation management users answered on behalf of themselves and added insight into usage within their respective groups.

> *We do [use citation managers], and, again, I know there are a few different ones, and some students use Mendeley. I've used EndNote more historically, but I find those to be quite useful and quite important. . . . It might be better if my full research group uses the same one, and that's something I should probably revisit.*
>
> *I use and my students all have on their computers, like, some sort of paper management software. So, I use one called Papers. And that's just because that's what I learned when I was a grad student. My students now use, like, Zotero or Mendeley. And so, you're probably familiar with those. But it . . . helps with organizing the PDFs and having them searchable. . . . That's something I insist on. Otherwise, it's impossible to keep track.*

> *I use EndNote to write papers . . ., because it's the easiest to get the citations into the papers and build the reference lists, but I use Mendeley for reading articles, because it syncs the best with my iPad. And EndNote might, but I think I have to pay to get enough space to store enough files for EndNote, and Mendeley you don't have to. Most of my students use Zotero, because it's free. And so I get forced into using Zotero. . . . And then I've also used an application for Macintosh . . . Papers. . . . Which is very pretty, but it's very poor at syncing to the iPad. So, I kind of gave up on that, but I still have it because all my old stuff was in there. . . . I think each student kind of has their own system.*

Others use more personalized or improvised systems of storage rather than relying on citation managers. One of these researchers suggested that increased disk space has made it possible to store all necessary journal articles and conference proceedings locally, even on a laptop: "Every project has its folder, and, under folder, we usually just put all the references of the papers, of presentations, that we collect." Another researcher applies a similar method with a shared drive so that students can also access and contribute.

Two researchers downplayed the need for information management and storage due to the ease of retrieving articles through discovery tools when necessary.

> *I think most of my students, if they have an article, they need to keep it, store it just then. I think I probably just ad hoc, you know? I used to have this drawer—until I need new paper, I'd print it out, and I went through that once, the whole cabinet, and it's like I had 10 copies of the same paper. So, it really isn't—I don't use any of the management systems like EndNote or something. . . . I guess I'm of the view that it's always at my fingertips. I'm not too worried about it. If I need a paper, I can always re-find it. I don't know if that's efficient, but that's how I view things.*

> *. . . in many cases, it's just a folder in my computer based on the product that it relates to. If I get it from the Web of Knowledge, I probably go back and get it from the Web of Knowledge again. If I get it from—as a preprint of something from another source, I look into my computer. I could organize my things better in the computer, but sometimes I don't find it. . . . It's like a relation of knowing where to find things. So, why do I need to have a big repository of things in my computer taking up memory if I can download from the same source that I used before?*

When asked for examples of resources or services that could help find or organize information more effectively, however, the latter researcher quoted above acknowledged that citation management support would improve his process.

Challenges in Finding and Managing Information

In listing challenges working with published information, several researchers commented on management and storage, with only two researchers (one environmental, one civil) noting issues with discovery.

Finding current, unpublished research is a problem, said one civil engineering researcher.

> *What's missing is ongoing research. So, there are some places where we can check and see what's the research ongoing, but it is so scattered. You cannot check all research institutions and sometimes this ongoing research is not well . . . placed on the websites. . . . I don't feel I have challenges with published information. But that published information is now becoming so old in certain fields and in certain things that we're doing is, we cannot allow them. We need to know what is exactly ongoing while we do more research. . . . We have a sponsored project with our local department of highways. The work plan has been revised four times because we discover information about ongoing research that already . . . nullified our first hypothesis.*

An environmental engineering researcher raised the issue of comprehensiveness as a challenge for both students and researchers alike. “You never know how fully well you've covered, you know, the topic or the area.” he said. “And . . . even though I do this for living, I'm still kind of a novice at this.”

Several researchers indicated a level of frustration with their current storage strategies and applying consistent strategies across a group. A researcher who uses Endnote to generate citations and Mendeley for reading articles on his iPad discussed the cost barrier in students widely adopting Endnote.

> *They don't make much money. They don't need to spend a hundred bucks on a copy of EndNote every year. Or, you know, a monthly fee on EndNote online subscriptions or whatever subscriptions, right. And so I think, you know, the more we can do it in a way that doesn't cost them money, the more chances we have of the students actually doing it.*

The same researcher explained that, despite best intentions, managing information is difficult, particularly across a group. He suggested a possible institutional solution to this issue:

> *If there was something . . . more specific to how the university systems worked that we could do. . . . You can set up your proxy or whatever or VPN, and then . . . your students will be able to get whatever. And . . . how could you set up a group-wide database of information that then you can access on your own as well?*

Another researcher who praised Zotero as an easy tool for managing his citations expressed dissatisfaction with it as an effective way to find saved articles.

> *It's not any quicker [using Zotero] than just doing another Google search. It's probably less efficient than doing another Google search.*

Working with Data

Of all areas covered in the interview, questions about working with data provoked the most detailed responses from researchers and revealed the most challenges. While this might be owed slightly to the design of the interview, which has a strong data emphasis in its questions, researchers were particularly forthcoming about their data processes and problems.

Notably, researchers uniformly framed data discovery, analysis, and management as group activities. Even researchers who answered questions about their research methods and information discovery and publishing habits in the singular "I" switched to the plural "we" in responses to questions on data. Without exception, their answers were not confined to individual researcher skills or preferences, but extended to the researcher's lab and student workers.

Also, in discussing data, researchers were more likely to tie together their practices and challenges. To best represent how data practices and challenges are intertwined, this section does not include a separate challenges sub-section in summary, but covers practices and challenges together in sub-sections dedicated to *Data Analysis*, *Data Storage*, *Data Produced by Others*, and *Sharing Data*.

Data Types and Formats

Both civil and environmental engineering researchers generate and use a wide variety of data types in varying formats. Researchers were asked to provide examples of both internally generated data and data obtained externally; these are listed below.

Civil engineering researchers: data types and formats	
Internally-generated data	• Physical testing results on paving material, produced continuously through the working day, typically saved via spreadsheets in Excel • Behavioral research based on driving simulator results: “it's human error type things: what they did, what they didn't do, what they said, and how they operated.” • Elements of traffic flow, including speed and lane position data • Compiler data, summarized from post-analysis experimental data • Large amounts of raw data based on computer simulations
Data produced by others	• Experimental data collected from the field on materials behavior • Published tabular data • National traffic data, “sometimes it is just recording what is going on in signalized intersection or something,” but also large datasets “where they have tracked so many drivers over so many miles”

Environmental engineering researchers: data types and formats	
Internally-generated data	• Large climate and hydrology datasets • Large chemical datasets about “point and concentrations in the atmosphere” (“I mean, not large in the sense of big data, but bigger than I can, you know, put on a piece of paper”) • GPS and mobile sampler data • Mass spectrometer data (e.g., molecular weight measurements will generate in “tens of thousands”; “thousands of data points in a single sample”)

	• Lab observation data (e.g., measuring properties of a sample using a pH meter or recording conductivity or temperature) • "[S]preadsheets or whatever kind of data organization tool the student choose to use. I don't really enforce any rules on them with regard to that." • Analyzed data from manipulated samples, which generates data captured in instrument's proprietary database and exportable to a spreadsheet • Daily samplings from a water treatment plant for reactor performance, and nitrogen and phosphorus concentrations • Genetic data for microorganisms, sequence DNA/RNA data
Data produced by others	• Large climate and hydrology dataset • Atmospheric measurements • Human-subjects data ("we don't actually deal with human-subjects data, but our data is combined with human health data that other people [gather]") • Meteorological and traffic data ("Anything that affects air pollution we're kind of interested in") • "long-term data on lakes in Wisconsin" • State DNR data • Multicolumn text files generated by synchrotron from national labs • Spectra data • Publicly available water quality data sets • Genomics data from NCBI (National Center for Biotechnology Information) database

In some cases, the line between internally- and externally-generated data is blurry due to analysis performed, such as in this instance provided by a civil engineering researcher:

> *Just as an example, we have a fiber optic line coming into the lab downstairs that brings, in real-time, all the state's current . . . Milwaukee, Madison freeways—the sensors out there getting speed, operation, density, flow. All of a sudden that just comes in, and so we are constantly storing it and then analyzing it. Then feeding it back to the DOT. . . . And the same way with crash data. So we have every reported vehicle crash since 1994 in the State of Wisconsin downstairs, so we can create algorithms and do data mining and look for information.*

Excel was the format type most commonly mentioned by researchers on both the civil and environmental sides for both internal and external data.

Data Analysis: Practices and Challenges

Although each researcher's data analysis methods are specialized to their areas of expertise, broad commonalities exist across civil and environmental areas. All researchers interviewed use a combination of pre-existing software and locally-created coding and scripts. Researchers in both areas use Excel, MATLAB, and R. Below are some examples.

> *So, we analyze it with different computer tools, and it's up to my students, but, you know, MATLAB or R or some other optimization software that we use. Some students use Python, and so I kind of leave that up to them if they have a preference. And some tools work better for others depending on what we're typically doing.*
>
> *Right now, we use Excel spreadsheets, and in certain cases, we write our own Matlab routines to do some advanced analysis and modeling. We also use statistical packages like Mini-Tab and SAS, which are available for us, you know, within the university to do statistical analysis and some statistical regression, fitting, and these kind of things.*
>
> *For bioinformatics, it's mostly things that people have developed to analyze that particular set of - those particular data sets. For certain things, a while back we were engaging to making the software to analyze some of this data. We found ourselves trying to do something that couldn't be done, but was available. So, we generated a couple of pieces of software to do that . . . there's a couple of servers that we host for two of these particular methods. There is a version of the software on the R environment. People can download and update, and the student that generated that was a master's student at the time here and is now a faculty member somewhere else, and he's continued to develop that tool.*

Although researchers often mentioned students using programming and software packages to conduct data analysis, none mentioned a formalized process by which they acquired these skills. A research group's work often benefits from students bringing in techniques learned independently, said one environmental engineering researcher:

> *I think they take—I forget what, there must be some crash-course in R down in microbiology that everyone takes to, kind of, get up to speed. They all know much more about it than I do.*

Another environmental engineering researcher emphasized the importance of students self-directing their learning about these applications, suggesting that this process empowers them to perform more complex analyses later in their studies. Students develop these skills in collaboration with their peers or by taking optional courses, the researcher continued, although this is not a lab requirement.

> *So, we have some students that come here with that skill. . . . Some students would be able to pick up that—those skills. Other could not. So, identifying the student's responsibility to identify whether they can really work with that or not, whether they need to collaborate with somebody else to do that or they can get started on their activities with that. So, that's part of the discovery of their own abilities. . . . There are some classes. People can take some classes offered sometimes by the Wisconsin Institute of Discovery or classes in other departments or bioinformatics and stuff. But, a lot of it has to be independent learning.*

Several researchers suggested that their lab's data management could benefit from more consistent operating procedures and documentation, including improved file-naming protocols and detailed explanations for the steps undergone and files produced in the process of analysis. One researcher claimed he would not be able to recreate his students' processes given current protocols in his lab.

Mindset can also be a challenge in data analysis. According to one researcher, some students have unrealistic expectations for processing speeds and the time required for analysis when it comes to large datasets, which can lead to procrastination and being overwhelmed.

Data Storage: Practices and Challenges

While differences exist among individual researchers' data storage plans and data management habits, there was no clear breakdown between civil and environmental emphasis. Most commonly, researchers save and back up their datasets on computers and local hard drives.

> *A lot of our data we just sort of store either on the system here at the university or students store it. In my other office, I have actually boxes and boxes of back-up CDs and hard drives from all my students. So I literally have copies of everything that all my students have done. . . . I don't think we have plans [for managing the data beyond its current use].*
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> *. . . all the students have their data on their own computers. I have a centralized backup server that they all back up their computers to. I do ask them to do things like spectroscopic data that the synchrotron, anyway, we keep in a centralized location. The rest of it—I don't know. You know, its instruments and probably the raw data files are mostly on instrument computers or raw observations are in notebooks. And then, you know, some interpreted form of the data is, you know, in Excel sheets on computers.*

Others use similar strategies, but supplement with the university's Box cloud file storage service.

> *. . . everybody backs up their own data, right, so on their computer and preferably on an external hard drive and then puts things on Box as well. And again, I try to remember this at about this time of year, when we start a new year—it's just as a reminder to students that it's, you know, important that they're backing things up on an external hard drive etc. . . . I think most of them are pretty good about that.*
>
> *So, for the students, they usually keep it individually on their computers. For things that I'm working on, I keep it on my computer. And then, I guess, then I back it up. . . . Sometimes, when they're collaborative, we'll make a Google spreadsheet or share it on Box. If it's something that a bunch of people need to look at . . . what I've done with my students that have finished, is they've given me all their data—like I have a, you know, shelf full of hard drives. So, I have copies of all of their data. Something I'm pretty strict about, actually, is the data needs to stay here.*

One researcher uses Box as the primary means of storage for internally-generated and externally-obtained data.

"It's basically folders of sponsored projects, industrial projects, and these kinds of things," he said. "And then, we have data and reports. So, we have a simple structure that everyone agreed to and they update their data, at least quarterly, sometimes more often."

Location notwithstanding, he said, data storage practices could benefit greatly from standardization in the same way that testing procedures already do:

> *. . . if you go in the log, every test procedure we have, almost all of them, we have a standard procedure. . . . Nobody will argue, "Well, you know, I have a better way of doing it." That's not you know, a question that anyone will ask themselves. . . . But, with organization of data, every one of all our researchers and staff, they would like to use their own way of really summarizing it and so on. So, standard protocols for organizing and storing data, could help tremendously. And I'm not saying that this is an easy thing, because you need to justify why the standard protocol needs to be used.*

An environmental researcher whose lab currently uses Box expressed some concern that it might not be adequate in terms of size for large datasets or in terms of accessibility and backup storage for some research groups.

A civil engineering researcher whose work involves large amounts of traffic data works with an expert in computer science and information technology to manage research data. This data is stored indefinitely on dedicated servers maintained by the university's Division of Information Technology.

Other researchers mentioned uploading some of their datasets to repositories for long-term storage. A civil engineer, who typically saves data on his local computer, has also uploaded materials data to ICSD (Inorganic Crystal Structures Database). An environmental engineer uses a variety of storage methods, including submitting to the NCBI (National Center for Biotechnology Information) database for long-term storage:

> *All the bioinformatics data is stored in the storage facilities—computer storage facilities in the Energy Institute, so everything's centralized and goes there regardless of where we sequence it. It's put there. For day to day activities and data generated from operational bioreactors, typically Excel file on box, like it's shared by everybody that is putting data into the spreadsheet. . . . it gets published and then, so the publications have the data that represent what we are doing, that's what's available there. Databases of large datasets get submitted to the NCBI repository, and then there's the number associated, access code associated with that in the paper, so, long term, storage of information is done in those ways.*

With the exception of one environmental engineering researcher, who led his group's transition toward electronic lab notebooks, none of the researchers interviewed currently use the university's electronic lab notebook service or require that their student assistants do so, although some interviewees mentioned it as an option for students or an area they would like to explore. While many researchers incorporate Box into their data workflows, one interviewee indicated reluctance to use it due to legal issues and preferred to exchange files "a little bit more manually." Participants do not make significant distinctions in their data management habits when it comes to data that they have generated and data they have gathered from external sources.

Researchers were not directly asked about documentation or metadata practices for internally-generated research data, but several interviewees noted the importance of them for analysis and storage.

> *. . . before any student graduates, I am very adamant about making sure that data is all available electronically, right? And well-documented and, you know, they need to have a very nice readme file that myself or any other incoming student who might be continuing that work could figure this out without, you know, pulling all of our hair out.*
>
> *The other thing that I think is always a challenge is, you know, that relationship between actual samples analyzed and the data generated and the experiments that were done to kind of generate those samples. You know, "What did you do in the lab or the field to generate them? How do you connect them?" And most of that knowledge resides in students' and post-docs' heads. You know, I think they do a reasonable job of recording it in lab notebooks. But, you know, I've tried to go back and, you know, finish up papers or whatever for students and, you know, you can't just do that by yourself. Usually you have to screen share with the student and be, like, "OK, walk me through what you did here and how you ended up wherever it is."*

The latter researcher also noted the potential loss of data in the case of specialized formats.

> *. . . I have my own personal library of x-ray spectroscopy data that I've been collecting for the last 20 years. And I always am in fear that, you know, some of the old data's in a special binary format that I'm sure someday will not be readable anymore, and so I won't be able to go back to my original, raw data.*

Documentation and retention of software or coding associated with these files might help address these issues.

Others noted the importance of good metadata in the context of datasets produced by others (see *Discovering and Working with Data Produced by Others: Practices and Challenges*), which suggests an understanding of how this impacts reuse and may indicate interest in improving their own metadata habits.

Data Produced by Others: Practices and Challenges

Most researchers interviewed claimed to have little difficulty finding data produced by others. Of the three civil engineering researchers interviewed, two found the majority of others' datasets through published articles, sometimes tracking the datasets to institutional or disciplinary repositories. One of these researchers, however, drew a distinction between discovering datasets and being able to access and reuse them:

> *. . . we try very hard to access data generated in other labs, but it's very challenging. In fact, there's a lot of debate among specialists in this field if there should be some international databases created. When we meet sometimes, particularly with groups from different parts of the country or, more specifically internationally, you see a lot of redundancy in our work in generating data, and—I think we can optimize our efforts, if we can get access to that data.*

Another civil engineering researcher receives externally-produced datasets through formal arrangements with federal and state agencies.

Environmental engineering researchers were more likely to find datasets through collaborations and personal connections, although one researcher relies primarily on the NCBI repository for external datasets.

Despite the relative ease with which researchers find externally-produced data, some expressed frustration in trying to make use of it in their own research. One common concern was reliability and provenance of the data.

‘[S]ometimes you get enough information and details that makes you feel, "Yes, this is really—was done in a reliable way,”’ explained one researcher. “Sometimes . . . when you see some trends, you can question whether this data is really valid or not.”

Resolving data formatting issues can also be a challenge, although not an entirely undesirable one. When students are challenged to reformat data, they tend to learn things not only about the formatting used, but about the data itself, as well.

Improved documentation and metadata would help address formatting, reliability, and reuse issues, as some researchers noted.

> *. . . anyone can run the lab and start playing with machines and, you know, generate data, but that data could mean really absolutely nothing. So, we're starting to see more and more people asking, "Well, who was collecting this data? What is the proficiency? How the training was done for the operators, and so on?" So, background about the operator proficiency and the standard procedure used, could help significantly.*
>
> *. . . the biggest thing, like, you know, the state DNR databases, in particular, [is] knowing what all the codes mean. Right, you know, they'll have codes that classifies wells and samples and how that all . . . backs up to . . . where the sample was taken, how it was handled, what was done with it before it was analyzed. And that's where having, working with someone at the DNR is kind of essential—otherwise, [we] wouldn't know what anything meant.*

Sharing Data: Practices and Challenges

Both civil and environmental researchers incorporate data into their published work by way of tables and appendices, and, sometimes in the case of reused data, acknowledgments. Researchers’ habits in sharing datasets or making them public, however, are less consistent and dictated largely by funder or publisher requirements, which can be confusing or difficult to follow.

> *I think our desire to make them available to the rest of the world was usually based upon requirements of us from funding agencies, programs that we've just been in. That's not something that we've done on our own. But the requirements to do that are ever increasing. And I think that's kind of a mess. I don't think there's a clear way of doing that. Some universities have their repositories. Some funding agents won't accept those. And so that's not really a permanent archive. There's different names. Journals are*

claiming that they do that. There's some other systems who are different. But I think that's just a huge mess.

So, in terms of all the data that we produce, we are not—and maybe we should be, but right now we are not—making that all currently available publicly. It's always available, certainly, by request, and, more and more, we are moving in that direction, particularly as NSF, etc., [make] these stronger requests. But I think that's something that we need to learn more about and figure out the best ways to do that. . . .

Publishing

All researchers interviewed publish primarily in scholarly journals, most specifying peer-review as an important consideration. Many interviewees are interested in the idea of open access publishing and in discussing the issues surrounding it; however, most said that cost remains a significant barrier for wide adoption of it as a regular practice. The most significant other types of scholarly output include conferences and technical reports to stakeholders, with only a few researchers regularly engaging directly with the public or using social media to publicize their research.

Choosing Scholarly Journals

Regardless of civil or environmental focus in their work, participants detailed similar criteria in choosing the scholarly journals in which to publish their research, often attempting to balance subject-specificity, wide readership, impact factor, and cost. Many target a small number of domain-specific titles.

Pre-tenure faculty (as represented by four interviewees) were slightly more likely than tenured faculty to mention impact factor as a consideration, and they were more likely to grant it more weight than other criteria. One tenured researcher offered an alternate metric of journal credibility:

I usually don't care too much about the impact factor. But I do have sort of this idea that if it's not in the ISI database, I won't want to publish there.

Researchers, tenured or otherwise, who mentioned impact factor or status of a journal title weigh this with other factors, such as the goal and audience of the paper, and speed of publication.

> *. . . there's one journal that's like a little bit higher impact. And so, we'll try to send like our really best stuff, there. They're also really strict. So, and are slow . . . Other journals are faster and a little nicer. So, it just depends on the paper, itself.*

> *We always try to publish in some of the more prominent journals, particularly if we believe that work lends itself towards it. We haven't shot for anything like, you know,* Nature, Science, *or some of these bigger ones yet. Hopefully at some point. But these other journals are very good journals. . . . You know, some of the work that we produce doesn't raise the bar as much as other pieces perhaps. . . . And so that may fit in more of a medium-tier journal, right? And that's okay, it's maybe more about being able to identify that early on versus knocking and rejection, knocking and rejection, knocking and rejection, right?*

Researchers also cited cost as an important criterion, particularly as the most critical factor in deciding whether to publish in Open Access publications.

Perspectives on Open Access

Six of the researchers interviewed have chosen to publish in Open Access journals, with one additional researcher mentioning that several of his sponsored projects required that he make the findings available via Open Access. Only one researcher claimed to publish very regularly in Open Access journals. Researchers repeatedly mentioned cost as the most important deterrent to their publishing in Open Access journals, even among those that support Open Access in principle.

> *When I was a post-doc, we published a paper that we paid to have open access. But I guess the biggest reason I do not usually is it costs money to us up front to do that. Well, cause, you know, it's like, the ACS journals all have open access options, but, you know, it's a few thousand dollars, I think. And at the end of the day the budgets are so tight on all the grants. . . . A few thousand dollars is tuition for a graduate student for half a semester, right?*

> *We have published in open access journals, a few. But I've never paid to have them—what do they call that—the flexible journals that can go both days. We've never paid for that. . . . I'm really against that. I have a real hard time paying $2,000, $3,000 to publish a paper.*

> *I'd love to publish everything open access if I had the money to do it.*

In a significant deviation from the other interviewees, who pursued publication in Open Access journals infrequently, one researcher estimated that 50-60 percent of his articles are published in Open Access titles.

> *A lot of the work that we're doing there is high impact and very novel in terms of activities, and the funding's available to do those Open Access publications. When I publish things related to wastewater treatment, the demand for those things is not as high. The people interested in those—in that particular niche just is less than the other. So, we don't tend to pay for Open Access there. We also publish in journals in which, like for example, the journals of the* American Society for Microbiology. *They make everything Open Access after six months. . . . So, you don't have to pay really extra and you know that your work is going to be open access where everybody can search it after a very short period of being restricted.*

Whether they publish widely in Open Access journals or not, nearly all interviewed researchers are invested in the topic of Open Access. Some expressed hopes for its broader implications for the publishing industry.

> *[T]here's a financial obligation . . . that is a hurdle that is difficult to jump. And then that's something I'd also like to learn more about, and I know that's an active piece of discussion with libraries. . . . And if . . . there were ways for us to make those more readily open access, we would be very happy to do that. In a particular type of research that we're doing, there's very little that we are trying to be the first one to do it and so we're keeping things under wraps until it can come out, right? It's kind of the opposite. If anybody's interested, we want them—we want to get this information out there.*

Others expressed concern:

> *I think Elsevier is probably the biggest publisher in the world. . . . So they have the option of making almost all the journals pay for open access. But one of the very bizarre things that's been happening in the past, like, six months or a year is there's been a tremendous assault on Elsevier or other publishing companies by the Swiss and German governments, where they've actually told government employees, which include university, that they were not allowed to be editors on their journals. And I've gotten backlash from people I've asked to review that said they refuse to review papers for a journal that's profit-oriented. . . . And they only will do open access. . . . And so that's a pretty bold statement, whereas I feel like, in Asia, it's the complete opposite. I think there's* not *a lot of support for open access. . . . They're really into the sort of more closed journals and subscription fees. And so I feel like this is going to kind of rip in half here.*

Other Publishing Outlets

In addition to scholarly articles, the research outputs most commonly mentioned by participants included conference proceedings and stakeholder reports, technical reports, and executive summaries for funded research. These often require a different approach to writing:

> *Sometimes a stakeholder requires something a little bit more, you know, digestible or engineering report-like. And so we will, we will tailor something specific to them. That might be, that might be, you know, very similar in terms of the story of a journal article, but that's something that they can read their way through a little bit better.*

Regardless of civil or environmental focus and tenure status, few interviewed researchers disseminate their research beyond scholarly journals, conference proceedings, and stakeholder reports. The only exception, a transportation researcher, mentioned that his lab's safety data is made available on the web and its research is featured in the media "quite a bit" due to public interest in transportation.

Social Media as Publishing Tool

Of the researchers interviewed, four do not promote their work or interact with colleagues over social media. Most of the others either use Twitter directly or rely on lab members to promote their research on Twitter and/or Facebook. One researcher uses YouTube to post videos of procedures under development.

Publishing Challenges

Researchers detailed several challenges in publishing, including technical problems with creating and submitting manuscripts, navigating the acceptance process, and broader issues with the publishing ecosystem.

One researcher expressed irritation with publishers' varying formatting requirements, and the work required to reformat an article after rejection for submission to an alternate journal. He praised LaTeX as a useful tool in addressing this, but noted its limitations as a collaborative tool in comparison with Word.

The same researcher mentioned poor pre-existing metadata as an issue in managing and using citations in a citation manager:

> *I wouldn't say the problem is the software itself. It's just these citations. When we download a citation from the lab, the formatting is not always good. . . . They have everything capitalized. They have some weird characters in the title that's not reproduced correctly. But it's not really a problem with Zotero. It's just—I guess it's a journal website. It's not well-maintained.*

Cost is also a substantial challenge. As discussed previously, researchers use cost as a criterion in deciding where to publish and, specifically, whether to publish in open access journals. It can also complicate reporting for funded projects.

> *There is a special issue in a journal in 2017, and we published three papers there and that ended up costing us quite a bit right and so that funding has to come from somewhere. It's not always easy to put that on a federal fund where there's maybe not allowed or not a line item for that, or we didn't budget appropriately for that, etc. So that becomes a real, you know, a real consideration.*

Money also complicates the process from a compensatory standpoint, according to one researcher.

> *I think this relying on free work from scientists to peer review papers is not sustainable in the next 20 years, you know? And I'm not opposed to paying to publish my work if I know the peer reviewers are even getting paid some nominal fee, you know?*

Length and difficulty of the review process also poses issues from both submitter and editorial perspectives.

> *. . . especially being a young faculty member, my biggest issues are always the time involved in the review process. You know, even journals that are relatively quick, it's, you know, six months before things from submission to, kind of, initial publication.*

> *. . . the percentage of papers being published is going down, so it is harder to publish. . . . I'm associate editor of several journals. I know the things that—the turnaround time is a*

> *challenge. Getting reviewers is a challenge. [Getting] qualified reviewers is a challenge in some areas.*

The publication process also functions as a learning experience for students, which can present challenges for researchers, even if the result is worthwhile.

> *. . . it's a teaching process when you're trying to publish your work, but you're also trying to teach your students how the communication through general publishing is about. Sometimes, things go slow and difficult because the students are just learning. So, patience for doing some of those things is necessary. I don't think that's . . . it's a normal challenge, put it that way. Some students write better than other students. Some need more learning and more guidance and more modeling.*

Recommendations

Librarians at the University of Wisconsin-Madison already possess or are in the process of developing skills that might assist with some of the problems cited by researchers.

UW-Madison Libraries' Science & Engineering Libraries, which include Astronomy, Chemistry, Geology, Math, Physics, and Steenbock Library (Agriculture & Life Sciences, Veterinary Medicine, Human Ecology, Engineering, and Computer Science), have begun to implement a research services model that closely aligns staff at these libraries and features two tiers of teams with each librarian working on a single team per tier. One tier is dedicated to functional areas of expertise (Innovation & Entrepreneurship; Research Data Management; and Scholarly Communication) and the other is dedicated to research engagement for specific Colleges or departments. This model, particularly in partnership with UW Libraries' Director of Scholarly Communication and Digital Curation Coordinator, offers many advantages in answering to civil & environmental engineering researcher needs as described in this study.

Given the fact that most of the researchers interviewed do not work consistently with librarians and typically consult with them only for hard-to-find published resources, raising the profile of other library services may present the biggest challenge. This may not require tremendous effort, though. Some researchers are already aware of library support in the areas of citation and data management; one researcher speculated on various ways he could be engaging library staff for support and regrets having not done so yet. His thorough, accurate list included having his students set up appointments with librarians or go to library training sessions on citation management software, data management, and developing information discovery skills.

> *. . . what might be helpful for me is if I set some of these things up so that when I have incoming students. . . , I can hand them one page and say, you know, "[here are] some of the things the library . . . provides, but here's some, also some things that—this is the way we typically do things: how do we handle our data, where do we store, how do we back it up so that we're kind of all on the same page?"*

Below are recommendations for how we might best engage.

Interdisciplinarity, Research, and Collaboration

Researchers revealed only a few challenges exclusive to collaborating with colleagues and none specific to working across discipline; however, the discussions yielded several important areas for library consideration.

- Researchers mentioned **sharing articles and other published works with international partners** as barriers to collaboration. In a broad sense, embracing open access would mitigate some of these issues, and librarians can function as advocates and educators on open access options; however, many researchers are reluctant to embrace open access publishing due to cost. Another option might be for librarians to help researchers identify journal titles with pre-print-friendly copyright policies and assist researchers in making their pre-prints available and discoverable when permitted.
- Researchers mentioned **sharing data with international partners** as a challenge, as well. Librarians who work with researchers on data management can prioritize international accessibility and discoverability when working with researchers on selecting data repositories for long-term storage.
- Six of the eight researchers interviewed mentioned **strong interdisciplinarity with chemistry**. This may have implications for the makeup of the Science & Engineering Libraries research engagement teams, which are still being formed. While library engagement with engineering faculty and students has previously focused on organizational structure (i.e., engineering librarians have liaised with departments in the UW College of Engineering), this presents a strong argument for a single engagement

team to work with the Department of Chemistry in the UW College of Letters & Science and chemistry-related departments within the College of Engineering, such as Civil & Environmental Engineering and Chemical & Biological Engineering.

Finding and Managing Information

Researchers are generally satisfied with their information discovery options, with most relying on Web of Science and Google Scholar and asking for librarian assistance when needed. Information storage and citation management present greater opportunities for library support.

- For many researchers, **information storage and citation management are collaborative challenges**. Due to the respective strengths and costs of citation managers, researchers and students within a single lab use different, and sometimes multiple, citation managers. Librarians with citation manager expertise could consult with labs and advise on citation manager adoption and usage based on lab needs.
- Some researchers **do not use citation managers or retain published information due to space concerns and the ease of finding resources**. Librarians could better promote time savings associated with the in-text citation- and bibliography-generating functionality of citation managers, as well as the ability to sync most citation managers with cloud services.
- While most researchers did not mention frustration with information discovery, one researcher raised the idea that **it is difficult to know when a search has been comprehensive**. Engagement librarians could better promote the idea that librarians will meet with individuals or groups to review literature searching and available library databases.

Working with Data

Without exception, interviewees discussed data practices as a group effort. Accordingly, librarians might make the greatest impact by pitching data services offered by the Science & Engineering Libraries' Research Data Management functional team and UW-Madison's Research Data Services, as well as campus workshops and online training subscriptions, to specific labs and research groups.

- **Researchers in both civil and environmental engineering make use of Excel, MATLAB, and R for data analysis.** Librarians could develop proficiencies with these common applications and/or help connect research groups (particularly new graduate student researchers) with campus resources for learning these applications, including library staff, campus resources such as data and software carpentry workshops, and the campus subscription to LYNDA.com.

- **Metadata and documentation were concerns for internally-produced data, but even more so for the discoverability and usability of data produced by others**. Librarians can promote the idea that data reuse is a two-way street, a desirable goal that can be best supported by accurate, readable documentation and metadata. Librarians can assist research labs in developing these.

- Although some have well-developed data management practices, **many researchers have devised improvised storage systems, and some expressed concern for the long-term storage of their datasets**. Some acknowledge that current strategies may not be adequate to satisfy funder requirements for data. Librarians could work with research labs to help create data management plans that satisfy funder requirements and allow for ease of use.

Publishing

Individual librarians have limited ability to directly assist with many of the big challenges cited by researchers in publishing, including cost and the review process. There are nonetheless, some valuable takeaways from our conversations about publishing.

- Despite low levels of adoption in their own publishing habits, **researchers are interested in open access**. Librarians should use this as an opportunity to involve these researchers in ongoing conversations on open access to determine if there are ways we can support them and navigate the potentially high costs involved.

- **UW Science & Engineering librarians might find support among some of these researchers in advocating for innovative, open access-favoring licensing agreements**

that remove the burden of cost from authors, such as MIT's recent 'Read and Publish' deal with Royal Society of Chemistry[4] (Fay, 2018).

Conclusion

UW-Madison Libraries are at a critical point in determining how best to deploy research services to faculty, staff, and students in many departments. By focusing our attention on civil and environmental engineering researchers, we can develop and promote skills to complement their specific research habits in the areas of Interdisciplinarity, Research, and Collaboration; Finding and Managing Information; Working with Data; and Publishing. Despite this specificity, many of these skills may be applicable to broader categories of researchers; this would best be supported by additional research habit studies conducted on other departments with whom the Science & Engineering Librarians engage.

[4] In this two-year agreement, MIT Libraries' subscription to RSC includes a provision that articles by MIT-corresponding authors published in RSC journals during this period are made openly and publicly available at no cost to the authors.

References

About - College of Engineering - University of Wisconsin-Madison. (n.d.). Retrieved August 16, 2018, from https://www.engr.wisc.edu/department/civil-environmental-engineering/about/

Academics - College of Engineering - University of Wisconsin-Madison. (n.d.). Retrieved August 16, 2018, from https://www.engr.wisc.edu/department/civil-environmental-engineering/academics/

Fay, B. (2018). MIT and Royal Society of Chemistry Sign First North American “Read and Publish” Agreement for Scholarly Articles | MIT Libraries News. Retrieved October 4, 2018, from https://libraries.mit.edu/news/royal-society-chemistry-3/27769/

Research Support Services | Ithaka S+R. (n.d.). Retrieved July 31, 2017, from http://www.sr.ithaka.org/services/research-support/

Appendix I: Semi-Structured Interview

Research focus and methods

- Describe your current research focus and projects.
- In what ways does your work engage with any other fields or disciplines?
- How is your research situated (or how does it fit) within the field of Civil and/or Environmental Engineering?
- What research methods do you typically use to conduct your research?
    - How do your methods relate to work done by others in Civil and/or Environmental Engineering [and, if relevant, in the other fields you engage with]?

Working with others

- Do you regularly work, consult, or collaborate with others as part of your research process?
    - If so, whom have you worked with and how?
        - Lab or on-campus research group
        - Other scholars or researchers [e.g. faculty at the university or other universities, student assistants, dissertators, independent researchers]
        - Research support professionals: e.g. librarians, technologists
        - Other individuals or communities beyond the academy
        - Others not captured here?
- Have you encountered any technical challenges in the process of collaboration? [focus on information-related challenges, e.g. finding information, data management, process of writing up results]
- What would help you more effectively develop and maintain collaborative relationships?

Working with Data

- What kinds of data does your research typically produce? [prompt: describe the processes in which the data is produced over the course of the research]
- How do you analyze the data? [e.g. using a pre-existing software package, designing own software, create models]
- How do you manage and store data for your current use?
- Do you use any other tools to record your research data? [E.g. electronic lab notebooks]. If so, describe.

- What are your plans for managing the data and associated information beyond your current use? [e.g. protocols for sharing, destruction schedule, plans for depositing in a closed or open repository]
- What challenges have you encountered in the process of working with the data your research produces? If so, describe.
- What would help when working with data?
- What kinds of data produced by others do you typically work with?
- How do you find that data?
- How do you incorporate the data into your final research outputs? [e.g. included in the appendices, visually expressed as a table or figure]
- How do you manage and store this data for your current use?
- What are your plans for managing the data beyond your current use?
- What challenges have you encountered working with other people's data?
- What would help you more effectively work with other people's data?

Working with Published Information

- What kinds of published information do you rely on to do your research? [e.g. pre-prints, peer-reviewed articles, books, technical reports, standards, patents, other texts]
  - How do you find this information? [Prompt for where and how they search for information and whether they receive any help from others in the process]
  - How do you manage and store this information for your ongoing use?
  - What are your plans for managing this information in the long-term?
  - Have you experienced any challenges working with this kind of information?
  - Are there any resources, services or other supports that would help you more effectively work with this kind of information?

Publishing Practices

- Where do you typically publish your scholarly research?
  - What are your key considerations in determining where to publish?
  - Have you ever made your scholarly publications available through open access? [e.g. pre-print archive, institutional repository, open access journal or journal option]. If yes, describe which venues.
    - Describe your considerations when determining whether or not to do so.

- Do you disseminate your research beyond scholarly publications? [If so, probe for where they publish and why they publish in these venues]
- Do you use social networking or other digital media platforms to communicate about your work [e.g. ResearchGate, Twitter, YouTube]?
    - If yes, describe which platforms and your experiences using them.
    - If no, explain your level of familiarity and reasons for not choosing to engage with these kinds of platforms.
- Are your publishing practices typical to those in your discipline?
- What challenges have you encountered in the process of publishing your work?
- What would help you in the process of publishing?

State of the Field and Wrapping Up

- How do you connect with colleagues in your field keep up with trends in your field more broadly? [e.g. conferences, social networking]
- How do you keep up with trends in your field? [e.g. conferences, social networking]
- What future challenges and opportunities do you see for Civil and Environmental Engineering?

Is there anything else about your experiences or needs as a scholar that you think is important for me to know that was not covered in the previous questions?

Appendix II – Invitation Email

Dear Professor ---- :

My UW Libraries colleagues and I are excited to be participating in an Ithaka S&R Research Support Services study this fall on Civil & Environmental Engineering researcher practices nationwide. This is part in a series of multi-institution, discipline-specific Ithaka studies designed to assess researcher needs in teaching and research, and to assist librarians in developing complementary services and resources. You can read more about Ithaka surveys and view reports from previous discipline-based studies here: http://www.sr.ithaka.org/services/research-support/

The UW Libraries research team for this project has a goal of interviewing 15 UW CEE researchers between October 2017 and February 2018. We will then share our findings with Ithaka S&R to create a cumulative report. UW library staff will concurrently use those findings to write a local report that will be made publicly available and to develop staff expertise in supporting your research. As we prepare for this study in the next few months, we hope to begin recruiting participants as early as possible.

We hope you'll agree that this is a promising opportunity for both UW Libraries and campus CEE researchers, and we appreciate any support you can lend to this project.

Sincerely,

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