Investigating the Practices and Needs of Civil and Environmental Engineering Scholars at Georgia Tech

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A study conducted in partnership with Ithaka S&R

by

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Introduction

Background

In 2017, librarians at the Georgia Institute of Technology (Georgia Tech) joined with librarians at 10 other research institutions in a project to examine the research practices of academics in civil and environmental engineering. The project was led and coordinated by Ithaka S+R, a non-profit organization that provides research and strategic guidance to help libraries navigate economic and technological change. The research was sponsored by the ASCE (American Society of Civil Engineers).

The project research consisted of interviewing 11 members of the research faculty in the School of Civil and Environmental Engineering, and subsequent analysis and reporting based on findings.

The specific researcher practices examined included such informational behaviors as: scholarly collaboration, information seeking, research data management, and scholarly communication and dissemination. The purpose of examining these practices was to find areas of opportunity where library services and resources can support the civil and environmental engineering researchers.

This report was created only from the Georgia Tech responses from the 11 faculty members interviewed. A national report will be created by Ithaka S+R, incorporating the anonymized transcripts of the collected interviews from all participating institutions[1].

The Field of Civil and Environmental Engineering

The School of Civil and Environmental Engineering (CEE) is one of the eight engineering schools in Georgia Tech's College of Engineering. CEE has an enrollment of 700 undergraduate students, 450 graduate students, with 50 tenure-track faculty, and 11 research engineers and scientists organized in six research groups: construction and infrastructure systems engineering; environmental engineering; geosystems engineering; structural engineering, mechanics, and materials; transportation systems engineering; and water resources engineering. Awarded over $20 million in sponsored research funds, CEE scholars contribute to society in four strategic, cross-cutting research areas: Resilient Systems and Communities, Energy Stewardship, Healthy Communities and Sustainable Cities, and Big Data and Smart Systems. They also collaborate with other researchers and conduct research in these CEE research centers: Brook Byers Institute for Sustainable Systems; Georgia Transportation Institute; Georgia Water Resources Institute; National Center for Transportation Systems Productivity and Management; and Southeastern Center for Air Pollution and Epidemiology.

[1] More information about the Ithaka S+R project can be found here: http://www.sr.ithaka.org/blog/supporting-civil-and-environmental-engineering-scholars/

Methodology

As one of the partner libraries of the Ithaka S+R project, the Georgia Tech Library created a research team comprising two subject liaison librarians, one for civil and environment engineering, and the other for aerospace engineering, as Principle Investigators. The research team submitted a study proposal for this project to the institute's Internal Review Board. As a requirement, the two librarians attended a two-day workshop, led by a senior researcher from Ithaka S+R, and held at the University of Delaware.

The authors then met with the Chair of the CEE to explain the purpose of the project and secure important administrative support. CEE faculty were recruited via emails. See Appendix 1 for a sample of recruitment letter and Appendix 2 for a sample of consent form. Eleven CEE faculty members, representing all areas of research in CEE, committed to the project.

Based on Ithaka S+R guidelines, the authors conducted individual, semi-structured interviews with CEE faculty within a two-month period. The interview questions focused on these general topics: faculty members' research areas, collaboration, research data, scholarly communication and future challenges. See Appendix 3 for a sample of the semi-structured interview questions used for this project. With participants' consent, the authors recorded all 11 interviews, averaging 60 minutes in length. The audio recordings were transcribed by a professional transcription service, and reviewed by the authors. Following the guidelines provided by Ithaka S+R, the authors normalized the transcription, and coded the normalized transcription through a grounded approach for further analysis. Interviewees and other related personnel remain unidentified in this report to protect anonymity.

Findings

The research faculty interviewed for this study, while all organizationally situated in one engineering school, were highly diverse in their research practice and expertise. There were many interesting ideas and insights shared in the course of the authors' interviews with these faculty. Though research areas in civil and environmental engineering are diverse, there are certain things that tend to have in common with respect to their research needs. What follows are some selected findings from the faculty respondents that stood out as notable, along with actionable recommendations for library responses.

Storing and Managing Research Data

The CEE faculty researchers at Georgia Tech work with existing data and with data they produce themselves. Existing data can refer to, for example, publically available government datasets, datasets obtained from a colleague elsewhere, or datasets purchased from a vendor. Data produced by the researchers themselves referred to experimental or personally collected or measured observational data. Some researchers use both their own data and already existing data.

Many of the respondents said that storing the data they produce and use was a challenge. Among the storage strategies mentioned were: Internal department servers, personal computers, personal hard drives, cloud storage, shared drive tools (like Dropbox), and lab notebooks. There was at least one researcher who used existing data for analysis and specifically indicated that they purposefully did not store data:

> *"[T]he data that we generate we can go back and generate again, quickly, because we're accessing, usually, public domain or agency data. [If] the data becomes difficult to access, then yes, certainly – when I get it I'll find a way to store it. But once it's public domain I don't see the need to store it."*

Respondents that did store data had varying degrees of concern about the storage and maintenance of data for the long term. Some respondents expressed a minimal concern for being able to handle data storage for their research needs (*"So [the data] are not large by today's standards…So storage has not been a big deal."*, and likewise, there were respondents that did not express a great concern that current data practices could lead to significant loss of research data ("I'm a pack rat. It might take me a while to find [my research data], but I always find it. We have got data in multiple locations […], but there could be a little bit more centralized data handling.").

Others expressed more concerns for how to store and maintain data for the long term. One researcher relied on partners at other universities to store data, since Georgia Tech facilities for data storage were not adequate:

> *"Frankly, the way we've been doing it is, we're letting our university partners do it, other universities. It's a little embarrassing, to be honest. That we can't, internally at Georgia Tech, actually archive data is just somewhat ridiculous. That's becoming an issue. All federal contracts are falling under that now. It's something that – somewhere, the university is going to have to resolve that."*

The limitations of data storage on personal computers, hard drives, and department servers lead to researchers having to spend more money to accommodate the data they collect and use. Researchers often use massive amounts of data, and, as one put it "We are often running up against data limits, and then we'll, through our grants, buy the additional storage material."

Other respondents reflected on the limitations of relying on personal storage strategies for their data: ("[T]here are times when we lose track of data. Then we know we've done it and we just haven't stored it in an organized enough fashion, and so we have to re-do it.").

There were also concerns about the loss of institutional knowledge, either through faculty or graduate student departures. One faculty member expressed fear that if a current graduate student left, he "wouldn't have a clue how to replicate what he's done […] so that always makes me nervous.

Other concerns raised by respondents included the risk of publically available data being taken offline, quality of publically available data, maintaining and upgrading storage devices, spyware and malware infections of storage devices, glitches in stored data, data being too dispersed, and recreating lost data.

In summary, while most respondents did not identify an urgent concern with data storage and maintenance, almost every respondent could identify weak points in their storage strategies that could be improved.

Research Tools

Depending on projects, CEE scholars employ various tools for design, modeling, and analysis, ranging from AERMOD (a modeling system for air quality, introduced by US EPA and the American Meteorological Society); to VISSIM (a microscopic multi-modal traffic flow simulation software package, developed by PTV Planung Transport Verkehr AG in Karlsruhe, Germany). Other design and modeling software respondents adopted include, but not limited to, such tools as: AMOS, CMAQ, LIMDEP, MAUT, MAP-LAB, MATLAB, Mathematica, and multiple in-house developed programs using C, or Python. The analysis tool respondents mentioned include: Excel, Minitab, R, SAP, SAS, and SPSS. They also adopt new tools for collaboration and productivity.

Researchers use different tools to meet the needs of various projects. According to scholars interviewed, often standard simulation tools may not meet the specific needs of clients. Take Smart City Project as an example, scholars need to simulate in real time dynamic data and it requires in-house development of programs to fit specific situations.

In addition, scholars try to create distributed versions, such as versions for different servers, computers or even mobile devices, so that the process would be faster given multiple processors, and the solution would be more resilient given variety of formats.

Some respondents stated that using innovative software tools is a part of the solution to problem solving. In the past, researchers relied on help from graduate students to create such programs. However, situations have changed. As one respondent put it, students these days usually don't have adequate training in developing software. Even some of them do have enough training or interests, scholars still have to face a turnover problem.

> *"…the students don't often have adequate training in developing software, so there's a ramp up to do that. Then you develop these large software systems, and the students are not permanent staff, and so you have got a turnover problem."*

One respondent was satisfied with the tools he had access to, but suggested that more campus wide coordination would be helpful. For instance, if one school has a license to a software, another school may get a discount on a second license to avoid both schools paying a high price. Obviously, more campus wide coordination would be helpful.

One respondent emphasized that technology changes that affect which tools are used in research are inevitable, and therefore the ways of doing research change.

Research Writing Skills

The publishing step in the research process is a vital and important step in the research process. And for the most part, respondents to our questions about the challenges of publication did not elicit a great variety of responses. Respondents were concerned about the long timeline of publication ("Most of the time, it's the review process that's long", "[Publishing] just took forever").

Lack of sufficient time is a consistent concern throughout most research faculty endeavors, and was not unexpected in the findings of the authors. A finding that was perhaps a bit more unexpected was the prevalence of the respondents to name 'writing skills' as one of the biggest challenges to their research practice. All respondents regularly published their own research, often working with graduate students. Several of the respondents specifically pointed out that one of the challenges they faced was getting their graduate students to write research articles clearly and effectively. As one respondent put it, "My frustration at times is […] getting them to write, and write well."

A primary concern for some respondents was the language barrier for non-native English speakers attending an English-speaking institution. One respondent said that "for some of the international students, their language is not good enough to get their work published." Another respondent added more detail:

> *"Quite honestly, particularly with some of my students that are not native [English] speakers, there is a combination of two big challenges. Number one, getting the work technically right, and then two, okay, did we actually get the work technically right, or am I just not understanding what you're writing? And I'm thinking you got the work right, but you explained it so poorly that I'm missing something that you missed. [...] Students are here to learn, and that's one of the things they have to learn: Okay, how do I take something that is a big problem, and I've done the work, now how do I synthesize it into a useful technical journal paper?"*

However, the perceived writing deficiency for graduate students in CEE is likely universal to both native and non-native English speakers. One respondent lamented that his students in general wrote poorly, and did not take advantage of the writing assistance resources offered by Georgia Tech's Center for Teaching and Learning (CTL). :

> *"And it's not just international [students], you know. A lot of Americans, I mean it's just shocking to me, some people get to graduate school and they cannot really write a good research report, even at a place like Georgia Tech. So that's the challenge, you know, any investment, and I think this is something that everybody would benefit. So I would support, you know, make it even mandatory for them to take that (CTL writing courses)."*

Some respondents had clearly been frustrated for a while at the problem of graduate student writing skills, and had given some thought to solutions, both automated and human. At least one respondent suggested that an Artificial Intelligence (AI) editor would be useful, one that could make a "first pass" and correct common grammar mistakes or improve awkward sentence structures. While technical editing is needed, the primary needs are tools and skills for fixing writing mistakes, whether text,

grammar, or syntax. As one respondent put it, this level of basic editing is a "waste of time, it's not a good use of resources. If I could get somebody to helm me turn [graduate student writing] into sentences I can read […] that would be amazing, amazing help."

Collaboration and Interdisciplinary Research

CEE research is interdisciplinary. More often, research grants agencies require multidisciplinary teams with multiple Principal Investigators in submitted proposals, especially for those multi-year contracts. CEE scholars collaborate with others on various levels. They collaborate with colleagues in the same research group, outside the research area, and other researchers across campus, as well as off campus.

Scholars from CEE collaborate with researchers from every engineering school from the College of Engineering, and many schools from other colleges. They work alongside with other researchers on campus through multiple interdisciplinary research labs and centers, such as Center for Nanomaterials Characterization, Digital Building Lab, Design Computation Lab, and so on.

CEE scholars' off-campus collaborators include researchers from other universities, such as Columbia University, Emory University, and University of Illinois – Urbana Champaign, others too numerous to name; from Department of Energy's national labs, such as National Renewable Energy Lab, and Oak Ridge National Lab; as well as National Science Foundation (NSF) Funded Multi Universities Center, and University Transportation Center, and so on. As an example, one scholar indicated that he writes on average 10-15 proposals a year with people from outside specifically for transportation research.

Collaboration Patterns

Collaboration is a norm in the CEE research environment, either formally or informally, face-to-face or virtually, and the patterns of collaboration vary from individual to individual.

Typical collaboration comes from within the civil engineering program. For instance, a faculty respondent in geosystems engineering has a working relationship with another faculty in water resources. Together with several other faculty members within the geotechnical group, they work on funded projects; each contributes to a section to each of those projects.

CEE scholars collaborate with other scholars on campus based on joint projects. A faculty respondent in structural engineering explained:

> *"In my area, some of the faculty in mechanical or aerospace have been on my students' doctoral committees. There have been some faculty like Prof. [Faculty colleague] in aerospace… coming into civil engineering and doing things and working on things that are more civil engineering problems."*

Another faculty respondent in infrastructure management teaches courses within CEE as well as in other non-engineering colleges on campus.

Collaborations come from communication. By reaching out, faculty build a partnership and do projects together. For instance, a faculty respondent in transportation area looks into how drivers interpret

work zones, or in other words, how drivers respond when coming into the active work zone. As the faculty described:

> *"… We were digging into some of those issues. I just said, yes, I want to do a [simulation]. I want to look into some other pieces on this. I just wandered over to the chair's office in psychology and said, hey, what do you think; and we built up a rapport and actually ended up doing a couple projects together."*

Some faculty establish close relations with local universities to further their research. For instance, a faculty respondent in environmental engineering works closely with faculty from Emory University and conducts monthly meetings on research progress. Usually, thirty or so students and four to six faculty members from each university attend such meetings. While Emory's emphasis is on public health, Georgia Tech's focus is on air quality engineering. Respondents indicated that this kind of unique collaboration generates productivity results.

One faculty respondent works with industry as well as academia to bring forward standards to the American Association of State Highway and Transportation Officials (AASHTO) Committee. As he described, "…this is what engineers are going to use to make sure your bridge is safe or your building is safe."

Some faculty work on projects that involve international collaboration. For instance, a faculty respondent studying geomechanics does analytical modeling, while collaborators from another university outside the county help collect local field data. They conduct joint experiments to explore future opportunities as well.

> *"… basically it's our mutual interest, because I do theoretical work, and that could help them design or predict what's going to happen [in their experiments]."*

Challenges in Collaboration

Almost all the CEE faculty respondents mentioned that lack of research funding and lack of time have been the top challenges in collaboration. Additionally, even though most researchers are willing to collaborate, the supporting systems sometimes are not sufficient. For instance, when each group does proposals differently based on different accounting systems, it takes time and efforts to make them consistent.

> *"There's just different mechanisms that different universities use. When you start passing things back and forth, that can just turn into delays, just these endless delays, trying to figure it out. With our other sponsors – the city, the state, whatever – each one, again, handles their accounting differently. You've got to work out systems to do it. It's not always trivial how one does that."*

Additionally, it is hard to track research progress since some researchers tend to work in silos. Some respondents hope for an internal platform for collaborated proposals to help with logistics and cohesiveness; others look for more open policy and transparency in projects on campus and from sponsoring agencies.

Several faculty respondents need more resources for writing proposals. A few respondents mentioned technology challenges, such as that some virtual meeting tools are lacking efficiency.

Collaboration is about people. As one respondent stressed, "I think if you have people, good relationships with the people you are collaborating with, and there's trust then there's no obstacle, except technological ones."

Future Challenges and Opportunities

CEE scholars are confident that the future is bright for research in the civil and environmental engineering fields. However, there will be challenges ahead. Almost all respondents mentioned that funding is a big challenge, especially to younger researchers.

For transportation research, there are urgent challenges and opportunities in response to the new technology development. As one scholar described, "the key thing right now is automation, automated and [connected] vehicles. That's going to transform the infrastructure [we use]."

Population growth in coastal cities and sea level rise are also important challenges, as a respondent put it, "we have to think about these things well, and not after the fact."

There are lots of new, emerging fields in environmental engineering, which post challenge and new opportunities for scholars to address comprehensive issues in the future. For instance, sustainability needs interdisciplinary collaboration in order to address the sustainability issue. Take food, energy, water systems as an example, it addresses three critical elements of human being needs.

Further areas of concern for CEE scholars include the state of the current infrastructure and global climate change, among others.

Technology innovation has provided vast opportunities for future researchers. One respondent claimed:

> *"I tell my students, there's never been a more exciting time in my whole, almost 30-year career, in travel research. It's never been more exciting than it is right now, because of the technological innovation that's going on; new services, as well as new products coming out – internet enabled, Smartphone enabled – that weren't even thought of in 1990 when I started. So it's a fascinating time, and exciting time – no shortage of interesting things to study."*

Data rich science changes researchers' frame of minds.

> *"Things started changing very fast, and now we're at a point where we have a plethora of data, and hence the models and the constructs that you were doing under the assumption of lack of data really and truly are either not applicable or not necessary. When you have a lot of data. You have to think of different constructs, different structures, and a different way of thinking of the problem."*

Recommendations

Based on the findings outlined in the previous section, there are some recommendations to consider to address the needs outlined by civil and environmental scholars at Georgia Tech.

Recommendation 1: Researchers need a common platform for data storage at the institute level.

Almost every respondent in our survey used personal computers and personal hard drives as a component of their data storage strategy. Some even kept back-up copies in their home *("I have a whole bunch of four-terabyte portable hard drives in a drawer in my study at home.").* While some respondents did not necessarily think that their storage practices were putting their data in grave danger, to some degree or other most acknowledged that the system was not perfect and/or that there could be a better solution in place. The recommendation for a common platform came from multiple interviewees.

The need for data storage will only grow in coming years. Therefore, the authors of this report suggest that researchers would be best served if there were institutionally-supported alternatives to personal data storage and curation, like a common research data repository, available to Georgia Tech faculty, staff, and students. The repository would need to be searchable, with options for granular permission capabilities to set wide or narrow access to the data. Such an endeavor will need to be addressed at a cooperative level among the library, institute IT, academic departments, and campus research administration, and will need to address such large questions as whether it be a hosted 3rd party solution, or an internally hosted solution is a question, who will take ownership of the solution, and how to fund whatever solution is implemented.

Recommendation 2: Librarians continue to engage with researchers (faculty and students) to provide data expertise and services.

As useful as an institute-wide data solution would be, the financial and logistical commitments required might make a unified or common data repository and platform more of a long term goal. For the more immediate future, librarians already working at the Georgia Tech library will need to engage directly with researchers to offer expertise in metadata creation, description, stewardship, access and preservation. Parham[2] discussed the expertise and services the library could offer in detail in her 2013 report "Stewardship of Research Data". The authors anticipate that there will be future campus-wide efforts to support data storage and curation, and librarian expertise would be utilized in such

[2] Parham, S.W., Murray-Rust, C. "Stewardship of Research Data" http://hdl.handle.net/1853/42091

endeavor. Expertise on its own is not a complete solution; the ideal data management strategy for an institute would also include a campus wide commitment to resources and infrastructure.

Recommendation 3: Librarians expand roles and develop expertise with research tools.

By constantly keeping updated on changes in research tools, librarians could stay abreast with the research trends and be more involved in the research processes. Librarians could explore relevant resources associated with their clients and make recommendations accordingly. As research tools change, librarians may have opportunities to expand their roles in offering training classes to faculty and researchers on some of the design, analysis and productivity tools.

Recommendation 4: Librarians continue to explore opportunities to collaborate with faculty to bring awareness of campus writing resources.

The writing process is an essential part of the research cycle. While there are offices and programs on campus designed to assist with improving the writing and communication skills of graduate students, there is clearly an opportunity to reach more students. The authors recommend librarian collaboration with existing writing offices and programs, such as the Graduate Communication Certificate program offered by the Center for Teaching and Learning (CTL). Georgia Tech librarians working closely with faculty could leverage their expertise with particular academic department's research processes and expertise in research instruction in a collaboration that benefits from CTL's expertise in instruction, instruction design, and effective scholarly writing. Additionally, librarians could use their close association with research faculty members to direct faculty to existing CTL writing programs geared specifically to the international student.

Recommendation 5: Librarians seek opportunities to work collaboratively with researchers.

The Library could explore opportunities to work with campus stakeholders on creating a more user-friendly, robust, and cohesive system for collaboration. With the restructuring of the Georgia Tech library organization, librarians are in a better position today than in the past to collaborate with others on campus and among themselves.

Recommendation 6: Librarians keep awareness of challenges in civil and environmental engineering research.

Keeping updated on the future challenges in civil and environmental engineering research provides librarians opportunities to make informed decisions in supporting research in these specific fields and beyond especially in terms of research resources, services and collaborations.

Conclusion

Research is evolving, and library resources and services must be responsive to that evolution. At Georgia Tech, the fields of study even within the School of Civil and Environmental Engineering (CEE) are broad and far ranging, and collaborations and interdisciplinary work is essential. There are broad experiences in collaboration, data collection and analysis, information seeking, information curation, and publishing behaviors, but with many commonalities. After interviewing faculty from CEE about their research practices, the authors shared some of the most notable insights with respect to collaboration practices and tools, as well as software tools for productivity, analysis, and design/modeling. The authors also shared findings related to storing and managing data, and the technical writing support needed for the graduate students studying under the research faculty. The authors made some recommendations for the library to consider for the purpose of addressing the findings.

The authors will continue to analyze the data for additional findings that would be of interest to the Georgia Tech CEE community and the library. The authors may also explore expanding this study in months and years to come to incorporate more CEE faculty, or even research faculty in other departments on campus.

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The authors would like to thank the civil and environmental engineering scholars who shared their time, thoughts, passion for their research, insightful remarks during the interviews. The authors would also like to thank Danielle Cooper from Ithaka S+R for her time and efforts in providing training, guidance and frequent advices. The authors are grateful for Cathy Carpenter, Head of Campus Outreach and Scholarly Communication at the Georgia Tech Library, for her support and keeping the project on track; and the Georgia Tech Library administration for their overall support of this project.

Appendices

Appendix A: Sample Recruiting Email

Dear CEE Faculty and Researchers,

The Georgia Tech Library is conducting a study to examine the research support needs of scholars in the School of Civil and Environmental Engineering at the Georgia Tech. Would you be willing to participate in a one-hour interview to share your unique experiences and perspectives?

Your perspective as a scholar in civil and environmental engineering will be incredibly helpful toward helping the Georgia Tech library identify and develop strategies for supporting the research needs of CEE faculty and researchers.

Our local Georgia Tech study is part of a larger suite of parallel studies with other institutions of higher education in the U.S., sponsored by ASCE, and coordinated by Ithaka S+R, a not-for-profit research and consulting service. The information gathered at the Georgia Tech will also be included in a landmark final report by Ithaka S+R and will be essential for the Georgia Tech to better understand how the needs of civil and environmental engineering scholars are evolving.

Thank you so much for your consideration. Please contact either one of us if you are interested in or have any questions about this project.

Best Regards,

Lisha Li
Civil and Environmental Engineering Librarian
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Fred Rascoe
Scholarly Communications Librarian
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Appendix B: Sample Interview Consent Form

Written Informed Consent Form

This consent form asks you to take part in a research study. The study is being conducted by Lisha Li (lisha.li@library.gatech.edu) and Fred Rascoe (fred.rascoe@library.gatech.edu) of the Georgia Tech Library.

Title of the research study: Research Support Services Study for the Field of Civil and Environmental Engineering

Reasons for the study: This research study seeks to examine the research practices of academics in Civil and Environmental Engineering in order to understand the resources and services these faculty members need to be successful in their teaching and research.

What you will be asked to do: Your participation in the study involves a 60 minute audio-recorded interview about your research practices and support needs as a Civil and Environmental Engineering scholar. We also may take photographs to document your workspace; however, you will not appear in the photographs. Your participation is completely voluntary. You are free to withdraw consent and discontinue participation in the interview at any time for any reason.

Benefits and Risks: There are no known risks associated with participating in this study. Subjects may experience benefits in the form of increased insight and awareness into their own research practices and needs.

How your confidentiality will be maintained: If you choose to participate, your name will not be linked to your interview responses or workspace photographs at any time. We do not include your name on any of the interview data and there is no link between this consent form and your responses.

Questions? You may contact the researchers at any time if you have additional questions about the study, or, if you have any questions about your rights as an interviewee, you may contact [Name] at XXX.XXX.XXXX or [Name] at XXX.XXX.XXXX.

I _____ understand and consent to participate in the study as described above including:

____being interviewed and being audio-recorded during the interview

____having my work-space documented through photographs

Signature of Research Participant: Date:

Signature of Research Participant: Date:

Consent Form Approved by Georgia Tech IRB: October 05, 2017 - Indefinite

Appendix C: Sample Semi-Structured Interview Guide

Semi-Structured Interview Guide

Research focus and methods

- Describe your current research focus and projects.
- How is your research situated within the field of Civil and/or Environmental Engineering?
    - Does your work engage with any other fields or disciplines?
- 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 with, consult or collaborate with any others as part of your research process?
    - If so, who 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, independent researchers]
        - Research support professionals: e.g. librarians, technologists
        - Other individuals or communities beyond the academy
        - Others not captured here?
- Have you encountered any challenges in the process of working with others? [focus on information-related challenges, e.g. finding information, data management, process of writing up results]
- Are there any resources, services or other supports that would help you more effectively develop and maintain these relationships?

Working with Data

- Does your research typically produce data? If so,
    - 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]
    - Have you encountered any challenges in the process of working with the data your research produces? If so, describe.
    - Are there any resources, services or other supports that would help you more effectively work with the data your research produces?
- Does your research involve working with data produced by others? If so,
    - 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 data for your current use?
    - How do you manage and store this data for your current use?
    - What are your plans for managing the data beyond your current use?
    - Have you encountered any challenges working with this kind of information?
    - Are there any resources, services or other supports that would help you more effectively work with the data produced by others?

Working with Published Information

- What kinds of published information do you rely on to do your research? [e.g. pre-prints, peer-reviewed articles, textbooks]
    - How do you locate 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, and YouTube]?
    - If yes, describe which venues and your experiences using them.
    - If no, explain your level of familiarity and reasons for not choosing to engage with these kinds of platforms.
- How do your publishing practices relate to those typical in your discipline?
- Have you encountered any challenges in the process of publishing your work?
- Are there any resources, services or other supports that would help you in the process of publishing?

State of the Field and Wrapping Up

How do you connect with your colleagues and/or keep up with trends in your field more broadly? [e.g. conferences, social networking]

- What future challenges and opportunities do you see for the broader field?
- Is there anything else about your experiences or needs as a scholar that you think it is important for me to know that was not covered in the previous questions?