

Building Support: Findings and Recommendations from Conversations with Civil and Environmental Engineering Researchers at Two Canadian Universities

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Introduction

In the fall of 2017 and winter of 2018, librarians from the University of Toronto (U of T) and University of Waterloo (Waterloo) interviewed civil and environmental engineering researchers at their respective institutions to learn about their research practices and needs [1], [2]. All of the researchers interviewed are tenured or tenure stream faculty with the title of Assistant, Associate, or full Professor. The interviewees will be referred to as “researchers” for the most part throughout this paper because that is the preferred term in the contexts described. The interviews were part of a larger study facilitated by Ithaka S+R, a not-for-profit agency that provides guidance to libraries and other types of institutions on conducting research that informs service improvements. Ithaka S+R has led several other versions of the study in various fields including agriculture, chemistry, and history.

U of T and Waterloo are Canadian universities with strong civil engineering programs. At U of T, civil and environmental engineering sits within the Faculty of Applied Science & Engineering’s (FASE) Department of Civil & Mineral Engineering (DCME). The department is split into five major research themes: cities and infrastructure, complex systems, energy and environment, transformative technologies, and mining and subsurface systems. The DCME is supported by librarians at the Engineering & Computer Science Library, which is one of 43 libraries at U of T, and contains the core collection of engineering, technology, and computer science materials on campus. At Waterloo, the Department of Civil and Environmental Engineering (DCEE) sits within the Faculty of Engineering. The department’s research areas of focus are environmental & water resources engineering, geotechnical engineering, structures, mechanics & construction engineering, and transportation engineering. At Waterloo, DCEE is supported by librarians in the Davis Centre Library, which is one of 4 libraries on campus and contains the main science and engineering collection on campus.

U of T and Waterloo were contacted by Ithaka S+R in 2017 and asked to participate in the civil and environmental engineering (CEE) project, and were the only Canadian universities to do so. Nine institutions from the United States also participated. Librarians from each institution attended training provided by Ithaka S+R at the University of Delaware in Newark, Delaware in October 2017. As all institutions would be following the same protocol, the training included an introduction to the project methodology, a lecture and hands-on exercises on interview techniques, tips on recruitment strategies, instructions and practice for coding interview transcripts, and guidance on writing the final report that each institution was expected to do. The American Society for Civil Engineering (ASCE) was also a project sponsor, as they have a

vested interest in knowing about their constituents' research habits and were interested in the outcomes of the research in order to continue to provide relevant programming to their members through their conferences, events, and continuing education courses.

Literature review

The librarian teams conducted this research to determine the information needs of civil and environmental engineering faculty in the hopes that these needs could be addressed through new or enhanced services at their libraries. This effort also aligns with the well-documented shift in librarianship from a focus on collection development and reference work to an engaged or embedded liaison librarian model [3], [4]. By having in-depth, one-on-one conversations with faculty, the librarians hoped to better understand the specific challenges CEE researchers face in order to become better partners in the research lifecycle. Both U of T and Waterloo have, in the past, conducted research that tried to address the research data management needs of their science and engineering faculty, including their civil and environmental engineering faculty [5]. While academic libraries in general, and U of T and Waterloo specifically, offer a number of services to support faculty and researchers including civil and environmental researchers, in-depth study of what these researchers require is limited. Other Ithaca S+R studies have been conducted with different institutions for diverse subject areas but this study was part of the first project examining the research habits of civil and environmental engineering researchers [6]. Other Ithaca studies include interviewing faculty from subject areas such as public health [7] and agriculture [8] and producing reports at the local level for participating institutions and a global report that summarizes the results from all of the participating institutions. As with the civil and environmental engineering study described in this paper, the goal of these studies was to help librarians (and other support professionals) have a better sense of the research practices of the faculty in their liaison areas so they can design and implement better research support services.

In probing the literature further, studies on the research practices and information needs of civil and environmental engineering researchers were found to be lacking. For example, Monroe-Gulick et al. [9] included STEM researchers in their study of the research habits and practices of their faculty at the University of Kansas, but no civil or environmental engineering faculty were included. Similarly, Zoellner et al. [10] interviewed education and behavioral science researchers but focused on their information seeking and storing practices rather than on their entire research lifecycle. Furthermore, studies on the research habits of civil and environmental engineers often focus on the citation practices of these researchers in order to inform collection development decisions, and usually focus on bibliometrics rather than surveys or interviews. For example, Aregbesola et al. [11] looked at what civil engineering students were citing in order to inform collection development decisions. Spence et al. [12] looked at citations for civil engineering faculty to inform collection development and retention decisions in three Canadian academic libraries.

Methods

This exploratory qualitative study was designed by Ithaka S+R. Two librarians from each research team attended a training session conducted by an Ithaka S+R representative, Danielle Cooper, to learn about techniques for interviewing, coding, and the final report writing. Research ethics clearance was received by the U of T librarians in mid-September 2017 with an amendment accepted in December 2017 and by the Waterloo librarians in late October 2017.

Waterloo librarians launched the project on November 16, 2017 with a recruitment announcement by the DCEE liaison librarian. Fig. 1 shows the timeline for the recruitment methods used by Waterloo. Various communication strategies were employed, including presentations at departmental meetings, emails, and in-person holiday card delivery. These repeated efforts coincided with the CEE Department meetings scheduled between November 2017 and January 2018, and were spaced out across this period to maximize the chance of faculty getting the message.

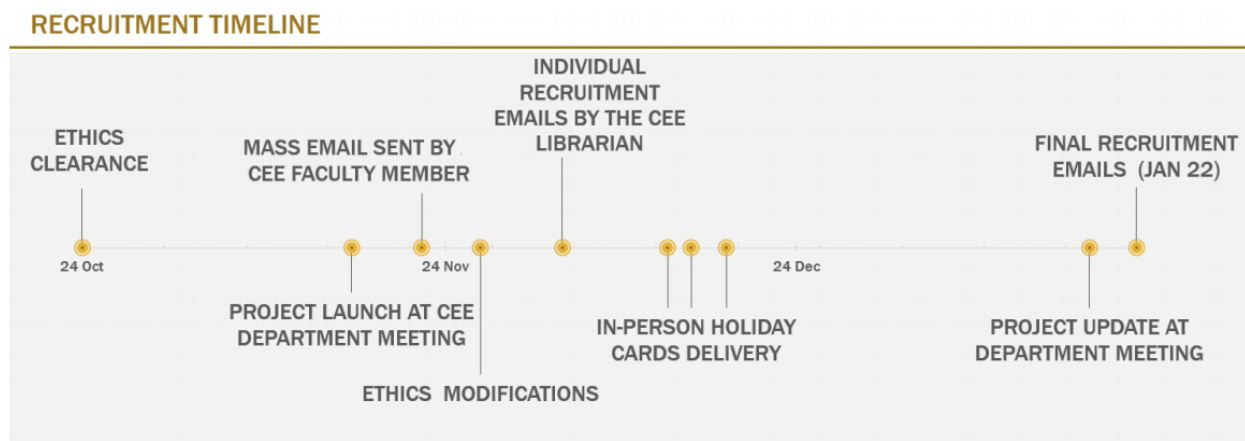


Fig. 1: University of Waterloo recruitment timeline (October 2017 - January 2018)

The librarian at U of T who liaises with DCME used a random number generator to select researchers within the department and, starting in December 2017, sent individual email invitations to these faculty inviting them to join the study. The chair of the department was also invited to participate.

Fifteen researchers agreed to participate in this study from U of T. One audio file was mistakenly deleted and so the final participant count was 14 researchers from a possible 44. Of the 14, four are Assistant Professors, four are Associate Professors, and six are Professors. Among those interviewed, there was at least one faculty member from each of the research areas in the department (see Introduction).

At Waterloo, only six out of the 42 faculty members participated in the study despite repeated recruiting efforts (Fig. 1). All six participants at Waterloo are tenured, Associate or full Professors. At least one researcher from each of the four CEE research areas was interviewed:

CEE Research Area at Waterloo	Number of Participants
Environmental & Water Resources	2
Geotechnical	1
Structures, Mechanics & Construction	2
Transportation	1

Table 1: Research areas of CEE faculty interviewed at the University of Waterloo.

The semi-structured interview guide developed by Ithaka S+R is included in the Appendix. All interviewees signed informed consent forms in accordance with each institution’s research ethics protocols. One-on-one semi-structured interviews were conducted with all of the participating researchers.

Interviews were conducted in the office of each participant by the DCEE liaison librarian at the University of Waterloo between November 2017 and February 2018. The interviews were audio-recorded using two digital voice recorders and lasted from 23 to 74 minutes. At U of T, two librarians split the interviews – nine interviews were conducted by the liaison librarian for DCME and five interviews were conducted by another engineering librarian involved in the study. The interviews occurred between December 2017 and March 2018. The majority of the interviews took place in the researcher’s office, unless they preferred to come to the librarian’s office. The interviews ranged in length from 20 to 100 minutes and were recorded using a digital voice recorder. In some cases, pictures were taken of the researcher’s work space, again, with special care taken to leave out or remove identifying features.

At the University of Waterloo, the interviews were transcribed, anonymized and checked for accuracy by the authors. At the University of Toronto, transcribing the audio recordings was done by graduate student assistants using a software called *Transcribe* to aid their work. The two librarians who conducted the interviews then checked the transcripts for accuracy and anonymity.

Three librarians from U of T coded the transcripts in a three-step process. A random sampling of three transcripts was chosen for step one, in which each of the librarians independently coded the transcripts by concepts. In step two, the librarians met and compared the conceptual coding to identify themes that emerged from the interviews. For step three, each librarian selected one of the three overarching themes identified in step two and then individually coded all of the

transcripts for their chosen thematic area. The three overarching themes that were identified and coded for were “research methods”, “research outputs”, and “collaboration.”

At Waterloo, the initial open coding was done by one of the authors on two interview transcripts. The codes were reviewed, discussed, and a list of themes and codes was created. The remaining interviews were divided between the two authors and coded separately in Excel. The results of the coding were discussed to ensure consistency in application and interpretation. Codes and key quotes were tracked in Excel and examined by the authors in order to determine key themes and trends.

Results and discussion

At the 2018 Canadian Society for Civil Engineering (CSCE) Annual Conference, a panel “addressed serious, urgent and growing issues for the profession, and for society: a) sustainability and climate change; b) inclusivity and social justice; and c) universal design of the built environment [13].” These themes were echoed throughout the interviews, with many participants acknowledging the great challenge and reward that comes with such an applied field of research. But with mounting pressures - from how impactful your field of research is, to how reputable the journal is in which you publish, to how expertly your data was managed - civil and environmental researchers expressed concerns about growing demands for their time, attention and research expenses. The following results and discussion section will examine these outside pressures, and investigate opportunities for each academic library to provide support.

Collaboration

Findings from both sets of interviews indicate that collaboration is at the root of the majority of civil and environmental engineering research done at U of T and Waterloo. For the interviewees, collaboration takes many forms, including within CEE, within engineering more broadly, and outside engineering all together. Some of the other disciplines that the researchers engage with include geology, geography, health sciences, public health, architecture, environmental sciences, economics, chemistry, physics, mathematics, and biology. One researcher said that working with experts in other fields has led to a realization that they “can measure things that couldn’t be measured before...[and that] might lead to a mystery, an answer to a mystery that no one’s known for 50 years.” In addition to academic colleagues, the participants noted they worked closely with municipal and provincial governments, industry associations, and the private sector, which is an obvious step given the applied nature of their work.

Often, these researchers are working on solving very practical and very pressing social, environmental, or infrastructural problems, and government policy or decisions can be directed by their research. The benefits of interdisciplinary collaboration are reflected in CSCE’s recent

strategic directions, such as leading sustainable infrastructure [14]. Such goals depend on collaboration with other associations, including the Canadian Association on Water Quality (CAWQ) and the International Society for Environmental Information Sciences (ISEIS) [15]. By pooling resources, expertise and experience, researchers are more adept at tackling large-scale, interdisciplinary problems, such as sustainability or universal design. However, working across institutions and with industry partners, these collaborations are not without their challenges. One researcher at U of T discussed how government partners have very high expectations about the deliverables that will result from the research partnership. While the expectation in academia is often to publish research, the expectation in industry is typically to implement this research into actionable plans. This dichotomy can lead to a disconnect with industry partners in terms of timelines, aims, and research outcomes. Interviewees also noted that collaborating with partners outside academia can be a challenge in terms of gathering and sharing data. Both industry and academia have a strong focus on protecting anonymity, which can make it challenging to effectively share and store data between them. Moreover, each group has different concerns related to data storage. Discussions around data sharing and storage among collaborators highlighted the need for the libraries to continue to work with their institutions to provide guidance, support, and infrastructure for researchers in the area of research data management.

Information seeking

Researchers at Waterloo and U of T share similar information seeking patterns. Most researchers interviewed name Google Scholar as their primary search tool but it is often used in conjunction with other online databases, such as Scopus, Web of Science, Engineering Village, the Library's discovery platform, PubMed, Science Direct, ResearchGate profiles, and Mendeley. Researchers are typically searching for journal articles but they also expressed a need for conference proceedings, industry reports, books, and freely available data from government databases. Civil and environmental engineering faculty interviewed at both institutions rely on graduate students to conduct much of this research, and will provide initial guidance for their students in terms of key authors or papers and then expect them to continue this research individually as part of their academic responsibilities. However, interviewees indicated that graduate students struggle with this task, specifically when identifying keywords. The impact of this challenge was articulated by a faculty member at Waterloo: "I wasted years working on a subject that I thought no articles had been done and had done tons of searches and my students had done tons of searches but we didn't know the word goniometer. If we had known the word goniometer, we would have known that somebody had done this." This issue could be alleviated through additional training on searching in academic databases. At U of T, training students on doing research was repeatedly indicated as something that would be worthwhile. It is interesting to note that there are already numerous opportunities offered at U of T for students to learn these skills, although it appears as though the library's marketing and communication of these opportunities could use some work. These offerings include faculty-wide information literacy instruction opportunities offered in conjunction with the graduate clubs for the different departments in the faculty, having librarians

come in to do instruction for a lab or research area, and individual consultation appointments offered on a first come, first served basis.

At Waterloo, DCEE graduate students receive library instruction each fall as part of a mandatory research methods workshop series. In response to these findings, the library has partnered with the DCEE graduate student coordinator to develop optional programming for the winter and spring terms. Workshops are targeted to graduate students based on research area, and faculty supervisors will have input on the topics covered to ensure that library programming matches their current needs. The program series launches in winter 2019.

Graduate students and research data management

Beyond information seeking, faculty at both institutions discussed the contributions of graduate students to their research. Students are assigned a variety of roles and duties: obtain data from industry, develop methodology, run experiments, publish results, analyze data (with the majority of analysis done by students with guidance from faculty), write scripts and/or code to generate input files, model results using software, conduct literature reviews and literature searches, conduct primary research, and co-author articles. Graduate students clearly play a key role in keeping a research program going, but they still pose a challenge to their supervisors as they acclimate to their roles in academia. As aforementioned, students may face challenges in conducting effective searches for their literature reviews. They also struggle to effectively manage their findings, both for literature searches and data mining. With data generation and analysis being one of the key research tasks, graduate students typically “each have responsibility for their own data management.” However, there was no universal strategy among the CEE researchers for archiving research data and files. Individual solutions existed within different groups and few faculty members had detailed data management protocols for their students to follow. Upon degree completion, graduate students were expected to transfer and archive their research data and files, but in many cases where processes are not established for students to follow, the results of a literature review or the data mined may be lost. The turnover of graduate students (Fig. 2) upon degree completion was noted to have an impact on research. One researcher commented, “in practice we’ve lost the vast majority of data that students collect over the past. The stuff that’s in the thesis lasts forever, the stuff that’s electronic we don’t have a system for that, and that is a weakness.”

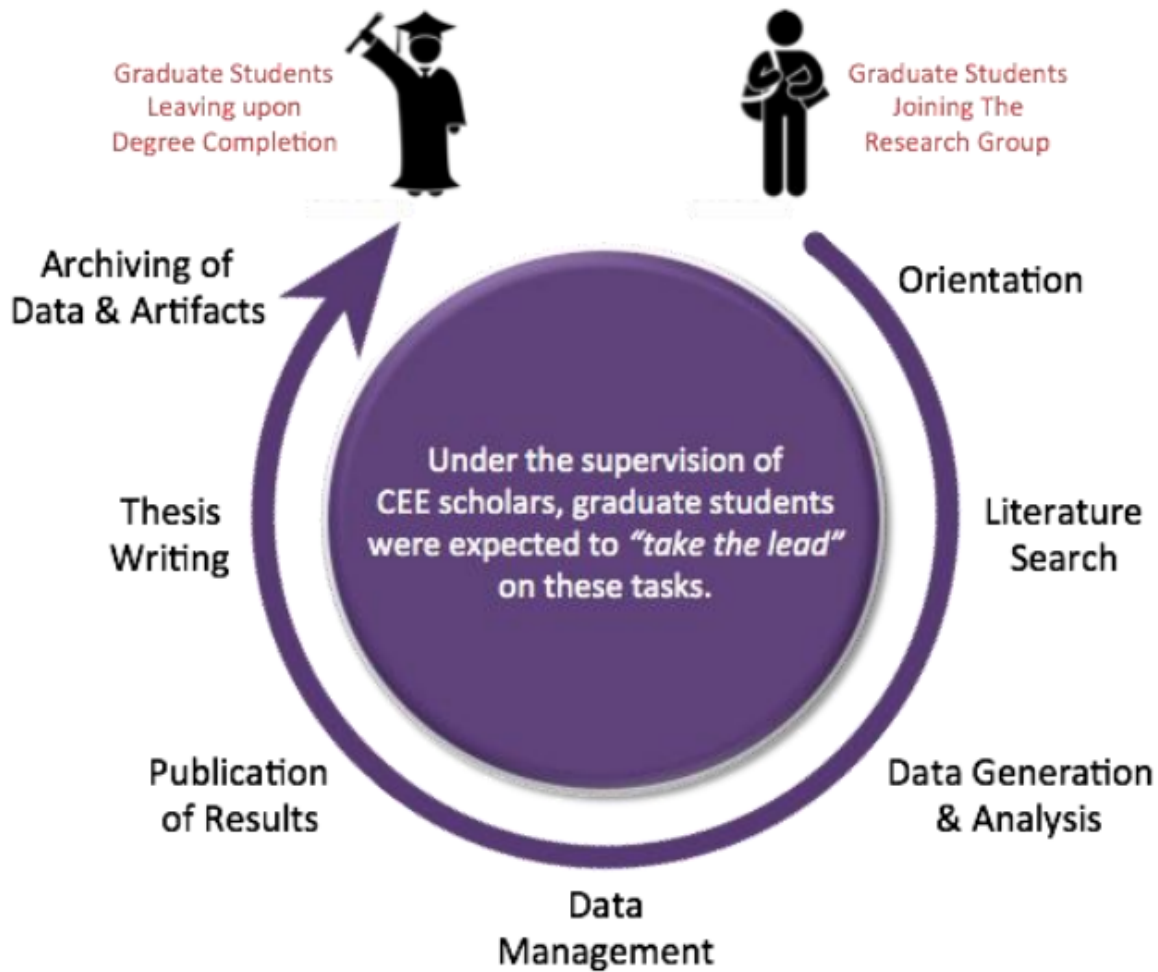


Fig. 2: Turnover of graduate students and their expected tasks throughout their academic career

At U of T, the research data management (RDM) librarians have created workshops specifically for graduate students to provide them with tools and methods for RDM best practices. However, the interviews show that more needs to be done to promote these workshops to researchers in DCME and this is the responsibility of the liaison librarian. Furthermore, the variety and amount of data produced by researchers means that RDM is a major concern for the institution as a whole. Issues around data management infrastructure, sharing, and preservation are well known and planning is underway. The RDM librarians at U of T are well-connected with the other stakeholders, for example the Office of Research and Innovation, and have a voice at the table as the institution decides the best approach to providing RDM support.

Disseminating research

In discussing how CEE researchers shared their research results, participants described balancing knowledge dissemination vehicles and their intended audiences (Fig. 3). The researchers took many things into consideration when determining where and how they would disseminate the

results of their research. When it comes to journals, the fit of the research to the journal was mentioned on more than one occasion, and includes factors such as if their peers are publishing there and the journal’s audience. The quality of the journal itself is also a consideration, taking into account who the chief editors are, who the big names involved in the journal are, the impact factor of the journal, the Source Normalized Impact per Paper (SNIP) measurement, and the reputation of the journal. Researchers are also cognizant of where they had published previously and did not want to over-publish in one journal. Time and ease are other factors that researchers consider when determining where to publish, with turnaround time mentioned by more than one researcher and acceptance rate also discussed. Researchers are trying to balance getting their research read by the widest audience and publishing in journals with high impact factors with how long it can take to get an article published and the likelihood of success. Practical factors were also mentioned, including “the sort of very cynical impact factor, is it going to help me get tenure?”

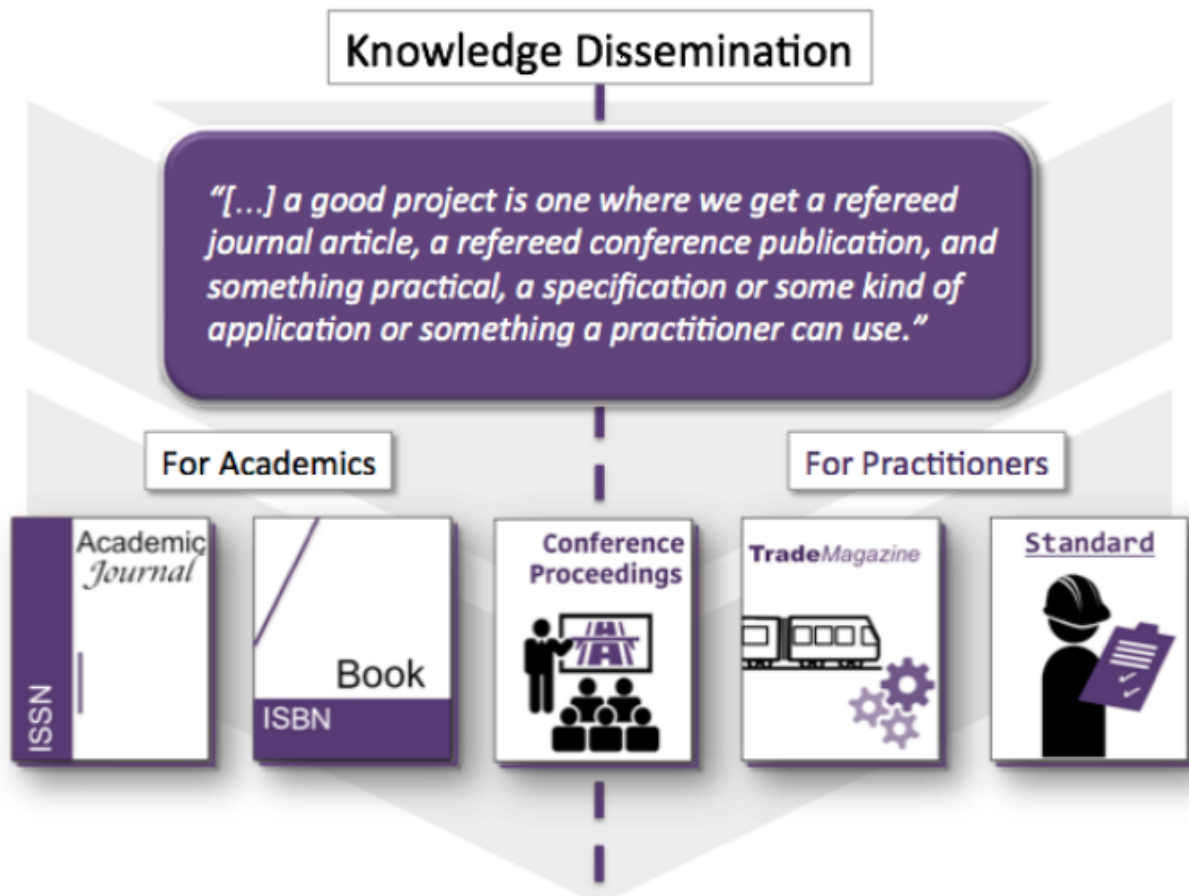


Fig. 3: Knowledge dissemination vehicles and their intended audiences

Conference papers were discussed and there were several factors related to decision making about authoring conference papers. When thinking about the scholarly sharing of research findings, researchers worried about compromising potential journal publications if they

published in conference proceedings. However, attending conferences was still seen as a valuable practice, in part because they attract industry partners as well as researchers. This might also mean that a journal that is more applied in nature is identified as a place for publication because “practitioners read it and [authors] know that the information will be used.” Other venues for reaching practitioners includes trade journals, specifications, association meetings, annual information days for partners, and government or agency reports. These other venues are not usually represented in traditional bibliometric research impact measures that are based on journal citation counts, so knowledge dissemination in these venues may not be reflected in a researcher’s bibliometrics rating. This means there is an opportunity for librarians at both institutions to work with researchers on identifying alternative metrics for measuring their research impact.

One interesting trend mentioned by more than one researcher was the importance of disseminating their research and findings beyond the academy and ensuring that their research impacted society. In some cases, this takes the form of standards and codes; in others, government policies or guidelines. When talking about codes and standards, one researcher commented “that’s the biggest way in which my work changes the way humans do what they do.” Other examples of ways that researchers disseminate their knowledge and research include offering courses and presentations to industry or practitioners in their area of expertise. Once again, this study’s findings reflect the values of the CSCE. It is clear that many civil and environmental engineering faculty at U of T and Waterloo are not doing research for research’s sake, but are working towards making a positive contribution to society and are interested in getting their research results to people who will benefit from it.

Open access

Participants were asked about open access (OA) dissemination of their research and how it fits in with their publishing practices. Responses around making publications available through OA were varied, and indicated a possible lack of knowledge around Canadian government granting agency publishing requirements. In Canada, the “Tri-Agencies,” which are the Natural Sciences and Engineering Research Council of Canada (NSERC), the Social Sciences and Humanities Research Council (SSHRC), and Canadian Institutes of Health Research (CIHR), instituted an OA policy in 2015. The policy states that all peer-reviewed journal articles published as a result of research funded in any part by the Tri-Agencies must be made openly available within one year of publication [16]. Despite this mandate, researchers generally found the OA landscape confusing and were not publishing OA with intent. Major barriers to publishing in OA journals that were mentioned more than once included the high cost of “author processing charges” for publishing in OA journals and the lack of funding to do so (Fig. 4). One researcher stated,

...it's difficult to justify the money for that expenditure, because we do work for a project whether it's an NSERC or whatever project, and we publish papers after the project ends, most of the time. Then we ran out of the funds. We don't have funds to supplement that cost. So open access publication for authentic publishers is a financial challenge to me. That's the only reason I don't publish in open access.

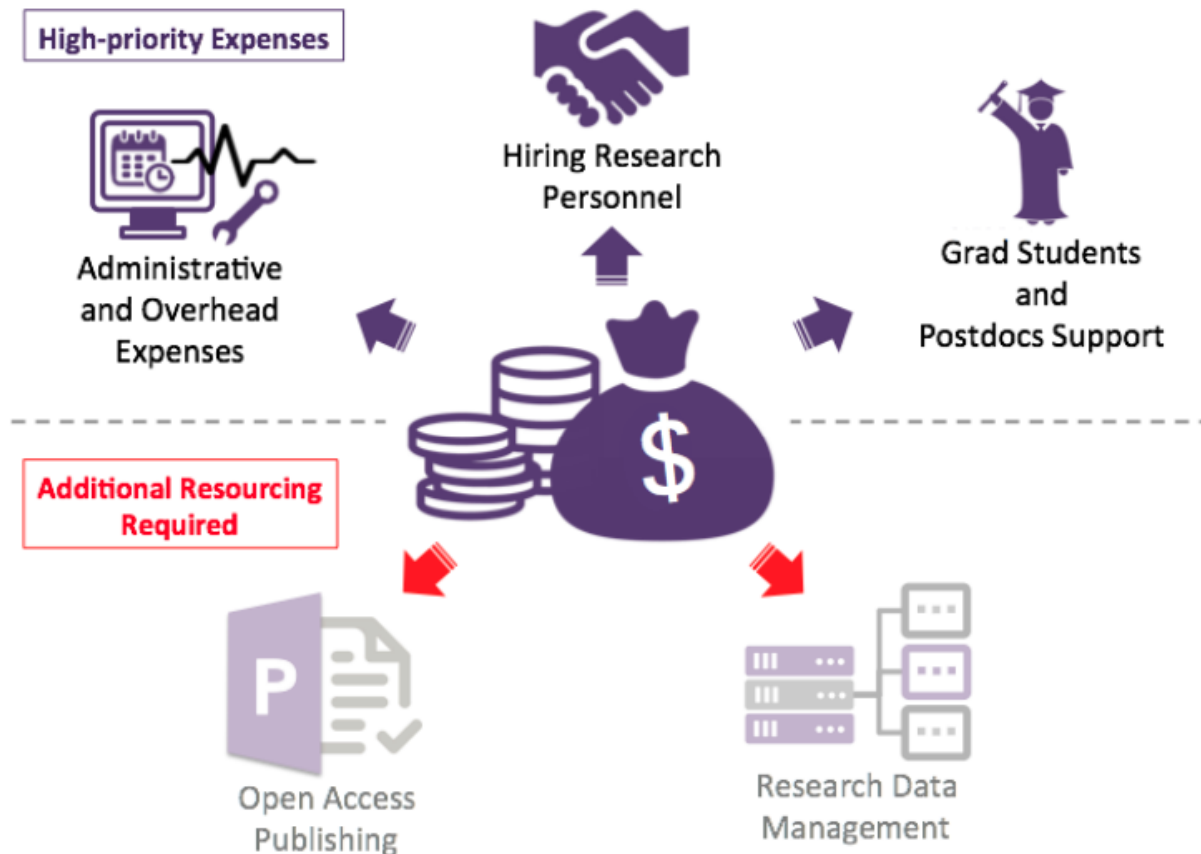


Fig. 4: Costs of doing research, and the lack of funding for open access publishing and research data management

In most cases, interviewees consider OA as synonymous with publishing in OA journals and not about making their papers available through an institutional repository like T-Space and UWSpace. Surprisingly, ResearchGate was mentioned more than once as a way that researchers made their publications openly accessible. This may be an area that librarians at both institutions can increase outreach, as ResearchGate is not an approved repository when it comes to Tri-Agency OA policies.

Lack of time was one challenge that came up as an issue in all areas of the research process at both institutions. Workload, grant writing, supervising students, publishing and disseminating research, and data storage and sharing were all areas where time was identified as an issue. While one researcher's tongue-in-cheek suggestion of needing a "time-turner" (like that used in

J. K. Rowling's Harry Potter series) is not a practical solution, there are many actionable items that both institutions can initiate in order to streamline the research process for our faculty. This includes:

- Data management and guidance on best practices
 - Share data management expertise with faculty, and include training for graduate students
- Data storage solutions
 - Including institutional cloud storage or suggestions of third-party platforms to store and share data
- Professional development workshops for students
 - Targeted, timely sessions on data management, information literacy skills such as conducting literature reviews and evaluating sources, and navigating the publishing landscape
- Promoting services already offered
 - Both groups noted that researchers asked for or suggested services that were already being offered, so promotion of these services needs to be improved at both institutions
- Communication and outreach
 - Improving communications with our respective civil engineering departments to help with promoting services offered to help them comply with Tri-Council Open Access policies

Conclusion

Civil and environmental engineering researchers at U of T and Waterloo are engaged in a diverse array of research activities involving multidisciplinary, multi-researcher teams. While both libraries offer a number of services that researchers expressed an interest in, promotion of these services is evidently lacking. This study highlights a need to improve communications and enhance services, especially in the training of graduate students. It also highlights areas where the library should continue to focus efforts, such as with research data management, open access compliance, and articulating research impact beyond traditional bibliometric measures. Some of these challenges are complicated, especially those related to research data management, and require a multi-layered institution-wide response. The findings from these qualitative studies can help provide decision makers with the insights into the kind of support that researchers need to proceed successfully in the area of civil and environmental engineering research.

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Appendix

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? E.g:
 - 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?
 - 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, 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?