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Research Data Management Faculty Practices: a Canadian Perspective

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Abstract

The inclusion of a data management plan in applications for publicly funded research grants has become standard practice in the United States, with academic libraries playing an important role in supporting faculty needs. In Canada, requirements for the submission of a data management plan as part of funding applications are a new consideration for faculty. These considerations are crucial in a large and multifaceted research-intensive institution such as the University of Toronto; however, studies focusing on the particular research data practices of engineering faculty are limited.

In order to create services that reflect the needs of our faculty, librarians in the University of Toronto Libraries administered a survey to all ranks of the Faculty of Applied Science and Engineering to determine faculty practice and attitudes toward storing and sharing their research data. Here, the authors present the results of this survey and discuss directions we will take in analysis and comparisons with other surveys.

Leveraging intra- and inter-institutional relationships in order to gain a richer understanding of the Canadian research data management landscape has been a key added element in this project. We discuss cross campus collaborations which resulted in adapting the original engineering-focused survey for use in all physical sciences disciplines at University of Toronto, and highlight some of the cross-disciplinary differences encountered. We also discuss ongoing efforts to partner with selected other Canadian schools to generate comparative data for cross analysis.

Keywords: research data, faculty practices, faculty attitudes, libraries, Canada.

1.0 Introduction

In the United States (U.S.), funding agencies have incorporated requirements for the submission of a data management plan (DMP) as part of a funding application. For example, the National Science Foundation (NSF) started requiring DMPs in 2011 [National Science Foundation (NSF), n.d.]. DMP requirements vary between funding bodies in the U.S., but typically they ask for a one to two page document outlining how researchers intend to work with their data. NSF requirements, for example, include types of data produced, standards for metadata, policies for access and sharing, provisions for protection of privacy, confidentiality, security, IP, and plans for archiving and preservation [NSF, n.d.].

In Canada, the three major public funding bodies are known as the Tri-Agencies or TC3+. The TC3+ “are federal granting agencies that support research, research training and innovation in Canadian postsecondary institutions” [Government of Canada, 2014] and include the Social Sciences and Humanities Research Council (SSHRC), the Natural Sciences and Engineering Research Council (NSERC), and the Canadian Institutes of Health Research (CIHR).

In October 2013, the Government of Canada released a draft framework for comment from the community which proposed “a collective realignment of agency funding policies regarding management of data obtained through projects undertaken with agency funds” [Social Sciences and Humanities Research Council (SSHRC), 2013]. Based on the framework document, one may assume that research data is a priority for funding agencies in Canada and there is a possibility that Canadian funding agencies could also incorporate DMPs as part of the funding process. Already in Canada, there are policies on data preservation for CIHR (2013) and SSHRC (1990), and on data sharing for CIHR (2013), though requirements differ between agencies [Canadian Institutes of Health Research (CIHR), n.d., SSHRC, 2014].

The explosion in production of data, and the complexity of these data, is bringing new challenges in management, curation, preservation and long-term storage. With insight into researcher needs and practices, libraries can play a valuable role in assisting with these challenges and fulfilling potential data requirements. To improve our understanding of our faculty’s current research data management (RDM) practices and attitudes, the librarians at University of Toronto’s (U of T) Engineering and Computer Science Library (ESCL) teamed up with U of T’s Research Data Librarian (Sciences & Engineering) to create a survey of all ranks of U of T engineering faculty and postdoctoral fellows. These are the users primarily affected by the requirements and these are the users who manage the labs. It is anticipated that graduate students may be surveyed at a later date.

Early in our process it became apparent that this survey could be adapted for dissemination to a number of science disciplines. The researchers decided not to survey faculty in the health sciences at this time due to different data management practices largely shaped by stringent ethics requirements. However, the authors are considering conducting the survey with other disciplines at a later date. At this preliminary stage, the authors restricted the survey to a manageable group of disciplines with the expectation that it could be rolled out to other areas at a future date. Therefore, the survey was expanded to include faculty and postdoctoral fellows from computer science, earth sciences, mathematics, statistics, astronomy and astrophysics, physics and chemistry.

The survey goals were to:

- determine how U of T science and engineering faculty and postdoctoral fellows manage and share research data beyond their project
- determine how University of Toronto Libraries (UTL) might help to facilitate data management activities
- understand some of the differences in research data management practices and needs across disciplines and sub-disciplines.

Results of the survey will be used by UTL to inform the overall development of RDM support services. The results can also help UTL librarians enter into conversations with researchers about perceived barriers and potential areas of opportunity or training needs, providing a better understanding of some of the factors motivating researchers. For example, an indication that researchers perceive the benefits of sharing data can make conversations around issues such as open data easier.

Results of the survey may also provide some insight into RDM practices in Canada. U of T is the largest academic institution in Canada and is a research intensive school with many of its researchers counted among the world's top. Approximately one third of the 146 invention disclosures and 13 of the 31 patent applications by U of T faculty in 2013-2014 came from Faculty of Applied Science & Engineering (FASE) ["Annual Report", 2014]. FASE produces some of the world's most ground-breaking engineering research, and consistently ranks as one of the top engineering schools in North America. FASE was recently ranked 24th in the world by both the Times Higher Education World University Rankings for Engineering and Technology, and Shanghai Jiao Tong University's Academic Ranking of World Universities for Engineering/Technology and Computer Sciences [University of Toronto Faculty of Applied Science and Engineering, n.d.].

1.1 Selected surveys informing our methods

The research team consisted of engineering, computer science and physics liaisons at the U of T. In the summer of 2014, a graduate student library assistant at the ECSL helped the research team to prepare a report describing survey tools used to collect information about RDM practices in five academic institutions. RDM surveys or reports from University of Minnesota [Johnson & Jeffryes, 2014], Purdue University [Carlson, Fosmire, Miller & Sapp Nelson, 2011] Utah State University [Diekema, Wesolek & Walters, 2014], the University of Nottingham [Parsons, Grimshaw & Williamson, 2013], and the University of Colorado Boulder [Rankin, Battenfield, Duerr, Hauser, Johnson, Maness, Parsons, Rajaram, Shoemaker, Stacey, Viggio, & Wakimoto, 2012] provided initial guidance to create U of T's survey. In particular, the factors mentioned by this research that were applicable to the U of T included: creating a survey short enough to reduce respondents' efforts and increase sample size [Diekema et al 2014], creating a pilot draft version of the survey to distribute to select faculty and project members to test the tool before questions were finalized [Parsons et al 2013] and the need to use discipline specific examples, reaching potential respondents in meaningful ways to encourage buy-in, and to think carefully about goals and perceived value to respondents [Rankin et al 2012].

Through fall 2014, additional surveys and related literature were consulted. These included, but were not limited to studies at: Concordia University [Guindon, 2014], Northwestern University [Buys, Shaw, Adams, Comerford, Doyle, Janzen, Klein, Rose-Lefmann, Lightman, Paris & Stewart, 2014], University of Iowa [Gu & Averkamp, 2012], University of Florida [Beile, 2014], Emory University [Doty & Akers, 2013], and universities in the United Kingdom [Cox & Pinfield, 2014].

2.0 Methods

The surveys described above were analyzed with a focus on survey design, sample composition, stated project goals, response rates, and population parameters. Using this information, a draft survey was created and the authors sought feedback from a number of sources. The first source was subject liaisons from chemistry, mathematics, statistics, astronomy and astrophysics. A U of T faculty expert in social sciences survey methodology provided feedback on individual questions and advice on the ethics approval process, survey organization, and testing of the survey instrument. A few individual faculty members from target departments, including three engineering faculty members, also provided feedback. These faculty members were provided with hardcopy draft surveys prior to participating in an informal "think aloud" exercise where they read survey questions and provided specific feedback. Their suggestions and reactions were analyzed, and where possible, suggestions were incorporated into the final survey.

The survey instrument consisted of 19 core questions, with an additional 2-4 questions that varied by departmental affiliation. Questions were organized into three sections: working with data, data sharing, and funding and services, with a fourth section requesting demographic information. Questions were multiple-choice (one answer), multiple-choice (multiple answers) and free text. The full survey can be viewed here: <http://uoft.me/4E> .

Responses were collected between April 14 and 28, 2015, using the subscription-based Survey Wizard online survey platform provided by U of T's Ontario Institute for Studies in Education. The survey was sent to a population of approximately 1081 possible respondents (numbers may be slightly inflated due to double-counting of cross-appointed individuals, or lowered due to underreported postdoctoral fellows or faculty) (Figure 1). Approximate population numbers were determined from a combination of information found on departmental websites and information obtained from administrative departmental staff at U of T. To encourage researcher responses, librarians attended faculty meetings in some of the departments surveyed prior to and during survey dissemination and spoke briefly about the upcoming survey. An invitation email with the link to the survey was distributed on April 14th, 2015 on behalf of the library by the individual offices of departmental chairs or departmental designates. The invitation can be viewed here: <http://uoft.me/56> .

3.0 Results and discussion

3.1 Limitations of research methodology

The results of this survey provide insights into the RDM practices of the faculty members and postdoctoral fellows at U of T who completed the survey. However, a few limitations exist within the survey design. Individuals who completed the survey were self-selected which may lead to bias; therefore, caution must be taken in any interpretation of the results. Raw percentages discussed in this paper are preliminary and representative only of the individuals completing the survey and cannot be applied to the larger U of T community or disciplinary groups without further research. The results and discussion herein can be considered preliminary and more analysis remains to be done.

3.2 Demographics

There were 140 participants that started the survey and 95 participants completed the survey. Responses reported here are based on completed surveys. At least one individual from each faculty, home institute, division or department completed the survey (Figure 1). Responses were obtained from postdoctoral fellows, lecturers and professors.

	Earth Sciences	Statistical Sciences	Mathematics	Astronomy & Astrophysics	Chemistry	Computer Science	Physics	Chemical Engineering†	Materials Science Engineering†	Civil & Mineral Engineering†	Biomedical & Biomaterial Engineering†	Electrical & Computer Engineering†	Aerospace Engineering†	Mechanical & Industrial Engineering†	FASE (not specified)†		Postdoctoral Fellow	Lecturer*	Professor**
Approximate Population	53	39	141	65	51	76	71	121	39	67	67	133	41	107	N/A		349	63	704
Sample Responses	5	1	4	9	8	4	20	9	1	10	8	8	2	6	4		19	8	68
	Departments Surveyed															Respondent Ranks			

Figure 1. Approximate population size and sample responses of individuals by faculty, home institute, division or department, and by respondent ranks N.B. Population numbers vary from the actual population due to data collection errors caused by cross-affiliation or lack of information. In the sample responses four FASE faculty members were cross-affiliated to more than one FASE department. Astronomy & Astrophysics include CITA and DUNLAP researchers. † denotes departments within FASE; “not specified” also includes Engineering Science and Engineering Communication. *Lecturer also includes senior lecturer and sessional instructor. **Professor also includes, adjunct, assistant, associate and emeritus.

3.3 Working with research data

In order to plan for appropriate support of our researchers, the authors wanted to have a sense of how many projects on average our researchers lead each year. The majority of respondents (62%, n=95) indicated they lead between 1-5 research projects in a year, as shown in Figure 2. However, 25% (n=95) of respondents said they lead more than 5 projects a year, possibly signaling a high demand for various kinds of support from the library.

Planning for possible infrastructure needs is another consideration. A question on data storage requirements yielded the following: 34% (n=95) of respondents estimate they use less than 50 gigabytes (GB) of storage for an average research project, although 15 of those respondents said they are currently leading 3-5 projects which could indicate a large demand on data storage for our institution in the future (Figure 2).

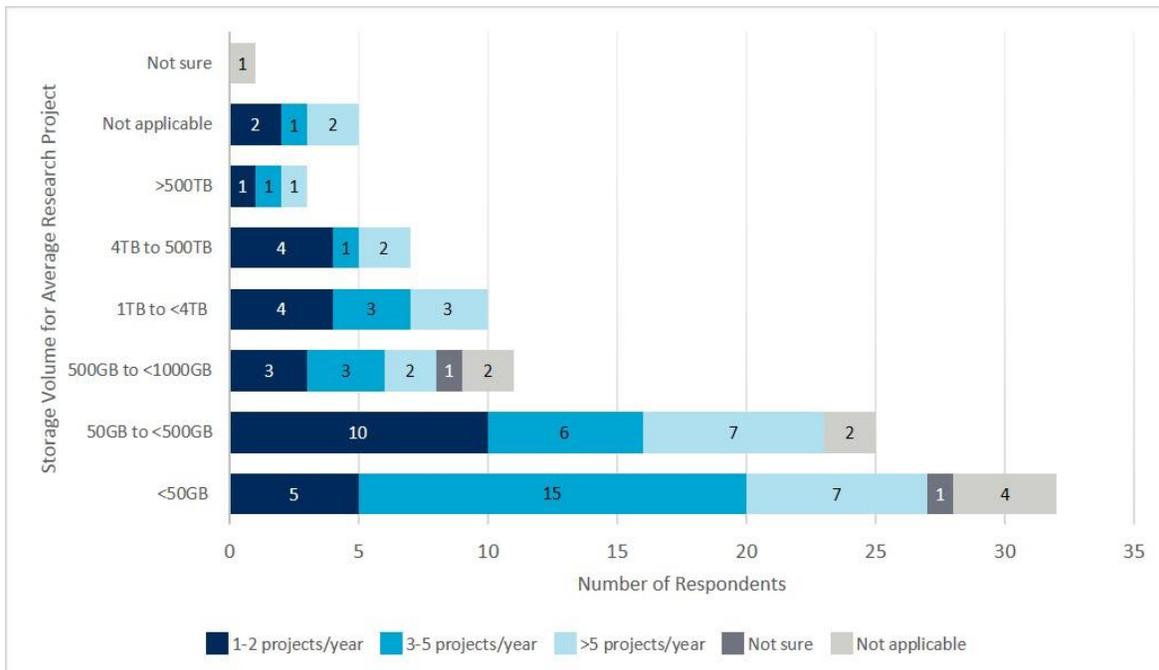


Figure 2. Results of question “how many research projects did you lead in the past year, for example, as a Principal Investigator or project lead?” in relation to the results from question “how much data storage do you estimate you use in an average research project?”

Relatively few respondents had a need for very large amounts of storage although as Figure 2 shows, one respondent who leads more than five projects also needs more than 500 TB per average project. The library in conjunction with U of T’s information technology departments and/or high performance computing centre may have to plan and prepare for this type of data need if other repositories are not available.

For the question “which of the following best describes the type of research data you generate or use in a typical research project”, respondents (n=95) could select as many options as applied. Respondents from the various disciplines selected a range of data types among the options geospatial (17%), instrument specific (45%), models (37%), multimedia (42%), software (36%), text (56%), other (16%), with the most often selected being “numerical” (64%). Most respondents selected several options.

When asked where they store their data, respondents (n=95) were asked to select all that apply. Results indicate they use a variety of storage options, with the most responses being computer hard drive (69%), laptop hard drive (71%), and external hard drive (64%). Interestingly, 41% of respondents selected “flash drive” as a storage choice, which raises concerns about security. Furthermore, 45% (n=94) of respondents indicated that they keep their processed data until it becomes lost or inaccessible – meaning they keep it indefinitely. It would be valuable to investigate whether storage location and duration of data storage are connected; for example, whether storage device obsolescence plays a factor in length of data archiving. This signals that the library may need to increase education around data security and proper data storing and archiving.

In a similar survey disseminated at Concordia University, 85% of respondents indicated that they use a personal computer hard drive or external hard drive as one of the data storage options [Guindon, 2014]. As indicated above, some U of T respondents also store data on hard drives.

Furthermore, 39% of Concordia respondents said they use a flash drive as an option for storing data. Respondents at the U of T also use flash drives. More research will need to be conducted to understand the level of security and long term storage risks that these common data storage methods present.

When asked to list any software used for analysis or manipulation of research data (n=84) there were 80 unique programs and tools mentioned, with the 15 most common responses being MATLAB (30), Python (16), Excel (14), R (9), IDL (5), ImageJ (5), custom software/tools (5), C (3), Fortran (3), LabVIEW (3), Word (3), Origin (3), Photoshop (3), ROOT (3) and SPSS (3).

3.4 Data sharing

Regarding data sharing methods, 17% and 11% (Figure 3) of respondents (n=95) stated they are not currently or not planning to share their data, respectively. Reasons stated by the respondents for not sharing data include, but are not limited to: insufficient time (47%); still wishing to derive value from the data (44%); lack of standards for sharing data (40%); and data being incomplete or not finished (37%). Twenty-two percent of respondents stated they are in fact willing to share their data.

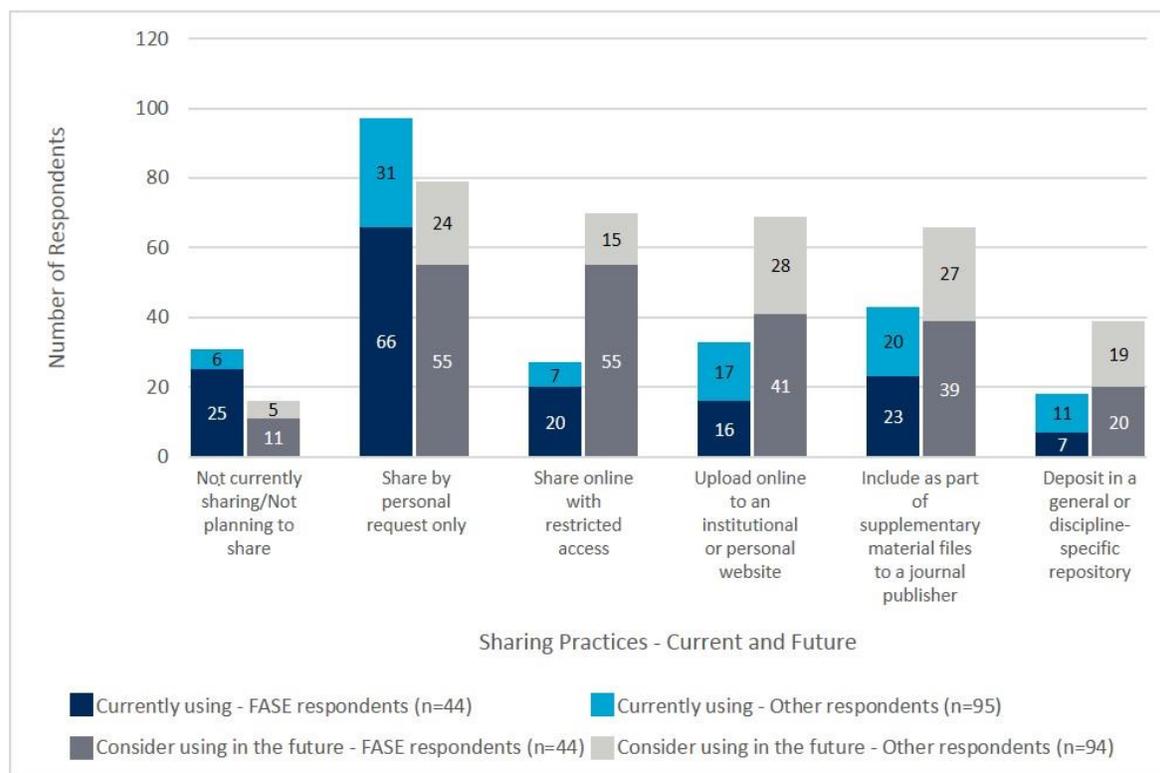


Figure 3. Percentage of survey responses to the questions “Which methods of sharing your research data do you currently use?” and “Hypothetically speaking, which methods of sharing your research data would you consider using in the future?” for both FASE respondents and all respondents.

An Emory University Libraries’ survey found there were also researchers at that institution who lacked time to share their data in a meaningful way [Doty et al, 2013]. This appears to occur in Canada and the U.S. [Tenopir, Allard, Douglass, Aydinoglu, Wu, Read, Manoff, & Frame, 2011].

Possible solutions to this problem include library instruction for graduate students on proper data management or creation of other library services to help faculty save time in other aspects of data management and sharing.

Respondents were asked to name any repositories with which they are familiar, and repositories in which they might currently, or in the future, consider depositing their data (Table 1). Given that our respondents expressed some interest in sharing data currently and in the future, this is an area the library can actively investigate for developing new services such as assistance in depositing research data in an appropriate repository.

Faculty or Department	Mentioned Repository
Faculty of Applied Sciences & Engineering	American Concrete Institute, CRAPome, European Bioinformatics Institute (EBI), GitHub , National Academy of Sciences, NIST: X-Ray Photoelectron Spectroscopy (XPS) Database, NEEShub, ONE-ITS, Open Data - Toronto, Physiome Project: The Virtual Physiological Human, ProteomeXchange, other institutional repositories
Department of Astronomy & Astrophysics	Canadian Astronomy Data Centre (CADC) , Centre de Données astronomiques de Strasbourg/Strasbourg Astronomical Data Centre (CDS), European Southern Observatory, GitHub , Infrared Processing and Analysis Centre (IPAC), Mikulski Archive for Space Telescopes (MAST), SAO/NASA Astrophysics Data System (ADS), other observatories
Department of Chemistry	arXiv , Cambridge Crystallographic Data Centre (CCDC)/Cambridge Structural Database (CSD), FLUXNET
Department of Computer Science	Evaluations and Languages resources Distribution Agency, GitHub , Linguistic Data Consortium
Department of Mathematics	arXiv , HAL
Department of Physics	academia.edu, AERONET, Canadian Astronomy Data Centre (CADC) , Canadian Network for Future Detection of Atmospheric Change (CANDAC), Earth System Grid Federation, GitHub , HepData, ICSU World Data System, Inorganic Crystal Structure Database, NASA Distributed Active Archive Centers*, NASA Langley Research Centre Multimedia Repository, Network for the Detection of Atmospheric Composition Changes (NDACC), Open Crystallography Database, Particle Data Group, Polar Data Catalog, Research Gate, Total Carbon Column Observing Network (TCCON), World Data Center for Paleoclimatology, World Data Center for Atmospheric Trace Gases, World Ozone and Ultraviolet Radiation Data Center (WOUDC)
*DAACs include: Alaska Satellite Facility, Atmospheric Science Data Center (ASDC), Crustal Dynamics Data Information System (CDDIS), Global Hydrology Resource Center, Goddard Earth Sciences Data and Information Services Center (GES DISC), Land Processes, Level 1 and Atmosphere Archive and Distribution System (LAADS), National Snow and Ice Data Center (NSIDC), Oak Ridge National Laboratory, Ocean Biology, Physical Oceanography, Socioeconomic Data and Applications Data Center (SEDAC)	

Table 1. Repositories mentioned by respondents that they are aware of, or would currently or in the future store data. N.B. Bolded repositories were mentioned by more than one Faculty or Department.

When asked about embargoes or other restrictions on data sharing, 34% of our respondents (n=95) indicated there were no restrictions on at least one of their research projects. Other respondents were restricted to sharing data due to the need to publish before sharing (49%), sharing would jeopardize intellectual property (29%), need to file a patent (20%), privacy issues, including patient data (19%) and contractual third party restrictions (18%). These restrictions must be taken into consideration when creating data management services for researchers.

3.5 Funding mandates and RDM services

When asked “Which funding sources have you used within the past 5 years, or are planning to apply for in the next 5 years?”, 78% of survey respondents (n=95) specified funding from the TC3+. Other funding sources identified in the study include other federal funding, provincial funding, and funding from industry partners.

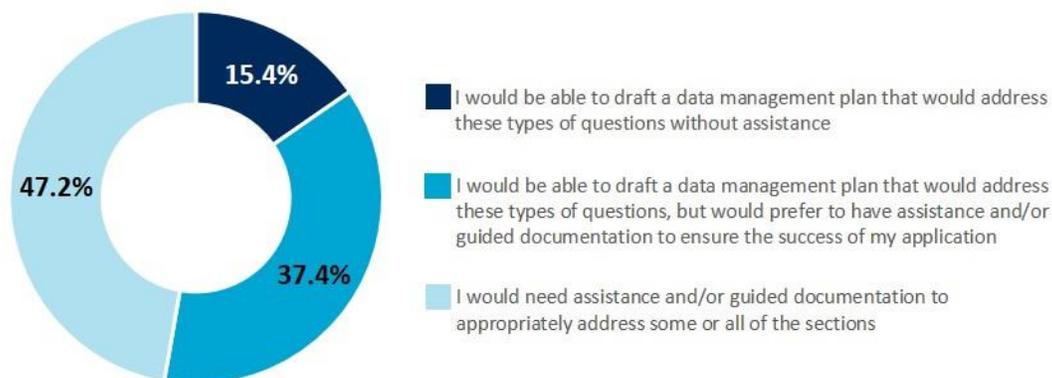


Figure 4. Responses to question “If you were asked to draft a data management plan as part of a grant application, which of the following statements would best describe your situation? Select one” (n=91) from survey. Typical elements of a data management plan were provided.

Approximately 15% of respondents (n=91) indicated they would be able to draft a DMP without assistance while close to 85% of respondents indicated they would prefer or require assistance and/or guided documentation to address these sections of a RDM policy appropriately (Figure 4). This indicates that services to assist faculty and postdoctoral fellows may be desired if DMP requirements are enacted by the TC3+.

As seen in Figure 5, over 50% of survey participants responded that they would be interested or very interested in all of the services proposed, with the exception of a service to assist with the digitization of physical records such as lab notebooks. Forty percent of survey respondents (n = 93) stated that they would not be interested in that service, and it was the service that received the most “not interested” responses (Figure 5). The services that received the highest percentage of “interested” or “very interested” responses combined were “assistance preparing data management plans to meet funding requirements, or assistance creating formal or documented data management policies” and “an institutional repository for long-term access and preservation of research data”. Seventy-seven percent of all respondents indicated that they would be interested or very interested in assistance with DMPs, and 65% indicated they would be interested in data storage and backup services. Looking at the responses from FASE participants only, for the same questions the percentages are 79% and 91% respectively. These results may give some guidance on what services to prioritize if DMP requirements are enacted by the TC3+. Although this does not indicate the desires of all faculty and postdoctoral fellows at U of T, it is evident that there is a desire for services, though the scale of those services is unknown. Other studies [Guindon 2014, Buys et al, 2014, Parsons et al, 2013, Doty et al, 2013] also found that there was an interest among faculty for data management services and training.

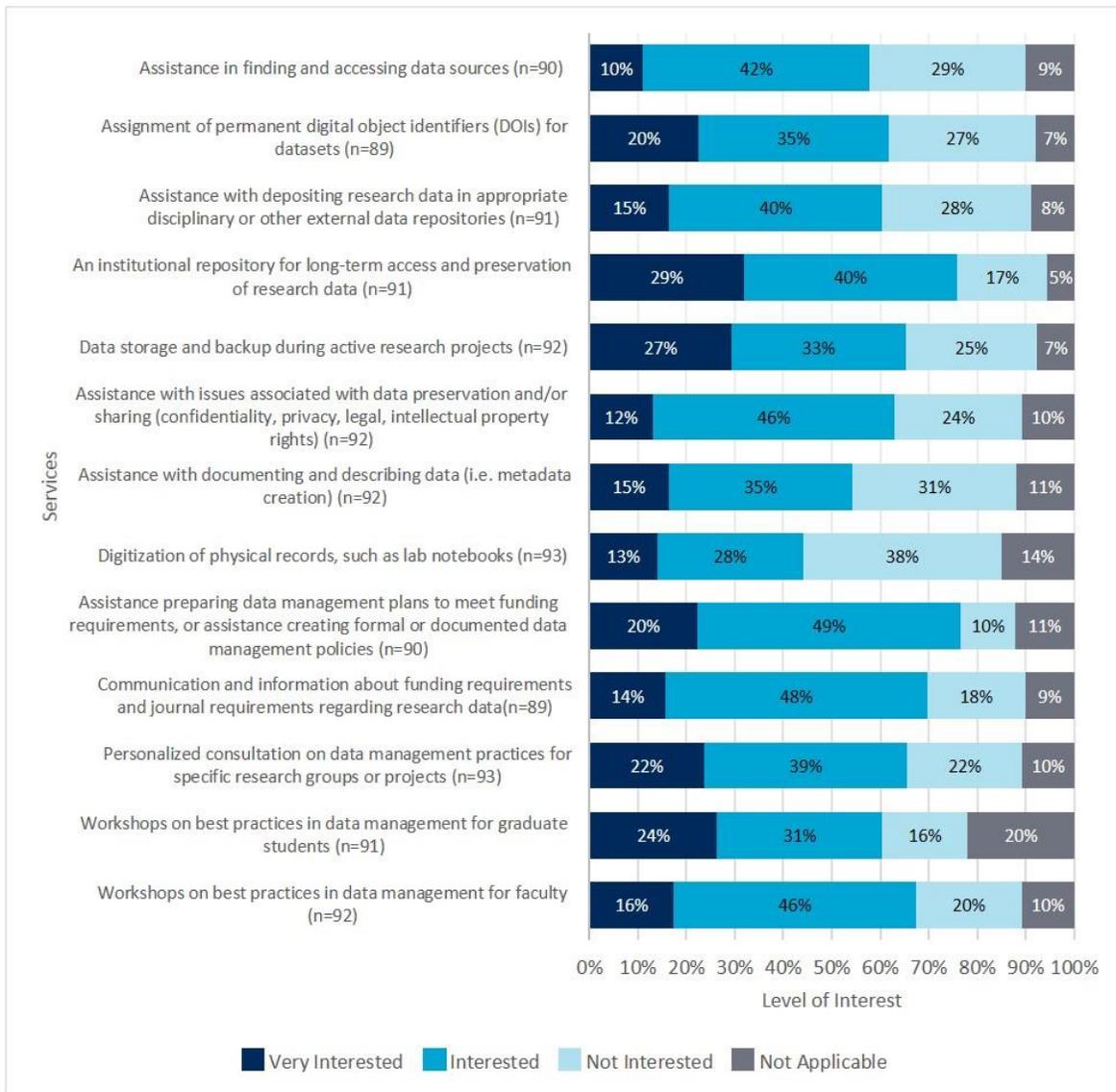


Figure 5. Responses to question “If data management plans were made part of grant applications from funding bodies such as NSERC, SSHRC, and CIHR, how interested would you be in the following services?”

3.6 Expanding to other Canadian institutions

RDM support is a fast changing and exciting new arena for librarians in Canada. Response rates for the survey were encouraging but this is only a beginning and more information is required. One way to gain a richer understanding is to run the survey in multiple Canadian institutions. Sharing the survey opens opportunities to generate cross comparative data, and this can increase understanding of the Canadian academic data landscape and the ways that libraries may prepare to support researchers. Creating a survey is a time consuming task and sharing resources such as this instrument can save valuable staff time.

The survey was initially offered to 6 of the largest engineering schools in Canada and conversations are underway with 4 of them to run the survey, with some adjustments to account for

site specific variations at their schools. At the time of writing, one survey was expected to run summer 2015.

4.0 Conclusions

With detailed statistical analysis pending it is difficult to reach any definite conclusions at this time, although there are some notable results. One general observation is that even within this small cross section of science and applied science departments, a wide range of RDM practices exist at U of T. Respondents indicated that they may need assistance with storage and security, and there was also a strong response indicating that researchers would need or want assistance if asked by funding agencies to create a DMP. Further, respondents indicated their interest in the types of services they might require in support of RDM.

Understanding the current practice and opinions of researchers regarding data preservation, data sharing and RDM planning is key to anticipating how their research workflow may be impacted by possible changes in Canadian funding mandates. Further, understanding the particular needs or habits within specific research areas can provide insight into how disciplines think about and work with data. Finally, a greater awareness of perceived barriers and benefits can enable targeted conversations.

Central to discussions of possible service and infrastructure solutions is understanding researchers' practices. The results of this survey, partnered with other related research and initiatives at U of T and results from research conducted at other institutions, can assist the library with its investigation of the development of a strategic direction for research data management support.

5.0 Acknowledgements

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