

# Observations on Research Libraries' Alignment with Institutional STEM Priorities

ASSOCIATION  
OF RESEARCH  
LIBRARIES



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# Summary and Synthesis

## Background

In 2021, the Association of Research Libraries (ARL) and the Canadian Association of Research Libraries (CARL) commissioned Ithaka S+R to consult with university leaders in the United States and Canada to identify their strategic priorities, to gauge their expectations of research libraries in achieving them, and together with our members, to determine what more research libraries can do to advance them.

[The report](#)'s findings were wide-ranging, sometimes hard-hitting, and were welcomed by our members.<sup>1</sup> Ithaka S+R identified four common strategic directions of research universities:

- The pursuit of growth, particularly in the STEM research enterprise
- At public institutions, efforts to engage the state, both through its political system and its population
- Redressing relationships with the historically marginalized, with significant variation between Canadian and US institutions in terms of how this priority is framed
- Defending the residential experience, which remains core to the educational strategy of most universities

Based on those common strategic directions and key trends in research practice and support, Ithaka S+R proposed a number of areas where the library could potentially seek to strengthen its alignment with university directions, the first of which was “**an accelerated pivot to STEM.**”

This merited further exploration, we felt. We wanted to tease out the need for and nature of such strengthened alignment, the challenges to be overcome, and to find some good examples of the ways libraries are already working to strengthen and support STEM at their institutions.

We want to be clear that this further exploration was a limited set of discussions: we conducted one-day site visits to four US institutions—Harvard University, Massachusetts Institute of Technology (MIT), Northwestern University, and Purdue University—and two Canadian institutions—McMaster University and University of Toronto. These presented a mix of public and private institutions located in reasonable proximity to us. While we prepared and pre-shared a working set of questions, the meeting itineraries were not standardized across the visits and there was much deviation from script.

As a result, we consider this “report” more a synthesis of learnings that may interest our members as they consider their paths forward in the realm of STEM alignment with their institutions.

The following observations on institutional contexts are limited to what is available publicly and what we learned through the one-day visits. The variations we share here are intended to provide a framing for further exploration as the reader considers what may or may not resonate within their context.

## Summary of Institutional Contexts

The six institutions’ missions are focused on the sciences or are science-heavy (McMaster, MIT, and Purdue) or are comprehensive of many disciplines (Harvard, Northwestern, and Toronto). Nevertheless, all of the institutions we visited are pursuing fields of research, teaching, and learning that have a significant STEM and related interdisciplinary focus. In some cases, there isn’t an explicit STEM growth strategy as the institution is or has always been STEM-focused (MIT and Purdue). However, in these and in the other institutions we visited, there are specific STEM and related interdisciplinary initiatives in pursuit of applied areas of research (such as biomedicine, climate, and artificial intelligence) or student growth (such as science communication and underrepresentation in STEM). Even in the institutions that are historically STEM heavy in their research and teaching, there is a focus on both the science of STEM and its societal benefits and implications. The stated drivers of initiatives or intentional strategies are sources of research funding (particularly the large sources) and the pursuit or continuance of prestige, such as institution and faculty rankings or membership in specific higher education associations.

Both Canadian institutions (like all Canadian universities) and Purdue are publicly funded; Harvard, MIT, and Northwestern are private institutions. And while their governance and legal constructs may differ, all are actively competing for research funding from public and private entities, such as foundations and corporations. The Canadian institutions seek public funding from three primary federal agencies (known as the Tri-Agencies) who together advance a national agenda: [Canadian Institutes of Health Research](#) (CIHR),<sup>2</sup> [Natural Sciences and Engineering Research Council](#) (NSERC),<sup>3</sup> and [Social Sciences and Humanities Research Council](#) (SSHRC).<sup>4</sup> The Canadian institutions are in the process of complying with the Canadian [Tri-Agency Research Data Management Policy](#)<sup>5</sup> and all senior administrators mentioned their focus on doing so. The Canadian institutions also seek funding in the health sciences from the [US National Institutes of Health](#) (NIH).<sup>6</sup> The US institutions seek public funding from multiple US funding agencies, which are currently collectively focused on delivering on the guidance issued by the [Office of Science and Technology Policy \(OSTP\) memo on “Ensuring Free, Immediate, and Equitable Access to Federally Funded Research.”](#)<sup>7</sup>

During our visits, each Canadian and US institution raised concerns about the additional administrative burden and service alignment needed to meet these funders' expectations. All six spoke to institution-wide initiatives to find synergies in research services, to better understand the funders' commitments to covering additional costs, and to optimize external relationships that could potentially distribute the responsibility and cost, such as [Dryad](#),<sup>8</sup> the [Digital Research Alliance of Canada](#),<sup>9</sup> and the [Big Ten Academic Alliance](#).<sup>10</sup>

The presence or absence of a specific institution-wide set of strategies or initiatives was initially thought to be based on governance structure—particularly in terms of stated degree of centralization and decentralization. In conversation, though, we learned this wasn't always the case. For example, McMaster, considered a highly decentralized institution, has high-level strategic priorities, a deliberate approach to cross-faculty appointments, and a Teaching and Learning Advisory Committee and university-level [strategy](#).<sup>11</sup> MIT, also highly decentralized, launched the [Office of Research Computing and Data](#) in 2022, which includes the MIT Libraries, MIT Information Systems and Technology, and the Office of the Vice President for Research.<sup>12</sup> MIT also established the [School of Science](#), which brings together six scientific departments focused on basic research.<sup>13</sup> While financial resources can be a driver to cross-institution collaboration, bespoke solutions also serve the needs of individual projects and centralized services may be seen as less attractive. Nevertheless, each institution spoke to the need to make it easier for the faculty and students to access research-related services and resources with a role for the research library. Examples include the University of Toronto (U of T) [Data Sciences Institute \(DSI\)](#)<sup>14</sup> and the U of T [Centre for Research and Innovation Support \(CRIS\)](#).<sup>15</sup>

Research libraries are undergoing significant workplace changes and this is also true for their institutions, including changes in leadership among presidents, provosts, and vice presidents of research—all key to aligning with the institution. In one institution the president and provost were leaving, in others a new president had just joined or was about to join, and in two institutions the vice president of research was departing shortly. These transitions created both opportunity and risk for the research libraries, as relationships are key to perceptions of what research libraries can contribute. With changes in leadership, it may be that the culture or ethos described during our visits informs how best to align with emerging or changing strategic initiatives, such as engaging with partners as part of a “collaborative and problem-solving” approach, focusing on innovation in a “do it yourself” culture, or looking for needed resources and delivering results in an “every tub on its own bottom” culture.

## Institutional Themes

Each institution has a stated mission and values. Some also have stated institutional priorities ([McMaster](#),<sup>16</sup> [Northwestern](#),<sup>17</sup> and [Toronto](#)<sup>18</sup>) or strategic initiatives ([Purdue](#)<sup>19</sup>). Some have action plans based on specific goals or schools, such as [MIT's "Strategic Action Plan for Belonging, Achievement, and Composition"](#)<sup>20</sup> and [Harvard's Faculty of Arts and Sciences strategic plan](#).<sup>21</sup> These tend to be all-encompassing or high-level, although McMaster's priorities include specific activities and metrics. Based on our conversations, existing strategic research plans (such as [Toronto's](#)<sup>22</sup>) or specific school or topical priorities, as well as strong working relationships with the provost, vice president of research, chief information officer, and deans, further clarify where the research library leader does and could align. Similar cross-institutional priorities emerged from our conversations. The following observations reflect themes we heard.

Eminence in research is called out explicitly in some of the institutional priorities; in other conversations we had, the institution's research preeminence was assumed and always expected. Regardless, all of the universities continue to seek significant research funding and consider funder relationships essential to carrying out their missions. This is measured in terms of a variety of factors, including the amount of research funding relative to peers, impact in terms of university rankings, and faculty or institutional inclusion in academic societies and elite higher education associations.

Not unrelated to sources of funding, interdisciplinary research teams are seen as essential in order to address grand challenges, such as the [United Nations \(UN\) sustainable development goals](#).<sup>23</sup> Emphasis in interdisciplinarity is evident in undergraduate and graduate programs, as well as research initiatives. For example, 100% of undergraduate MIT students study both the humanistic and arts fields.<sup>24</sup> MIT's School of Science addresses "fundamental questions and society's great challenges."<sup>25</sup> Purdue added 40 new liberal arts faculty positions to support the STEM programs' core courses; for example, a student can do a BA in philosophy focused on AI ethics. At McMaster, in most of the undergraduate programs in science, engineering, and health sciences, the professors have cross-faculty appointments, with increasing engagement with the social sciences, business, and humanities. Northwestern's focus on [innovation and entrepreneurship](#) is interdisciplinary by nature and offers students communities, facilities, mentors, fellowships, and funding.<sup>26</sup> Cross-school research initiatives are common, as well. For example, [Harvard's list of cross-school initiatives](#) is extensive,<sup>27</sup> [Toronto's Institutional Strategic Initiatives \(IS\)](#) foster interdisciplinary research clusters,<sup>28</sup> and [McMaster's Brighter World campaign](#) focuses on grand challenges.<sup>29</sup>

There is a focus on equity and inclusion in STEM at all six institutions and every institution has related cross-institution initiatives. MIT has the [Center for Research on Equitable and Open Scholarship \(CREOS\)](#).<sup>30</sup> All six have programs focused on women in science.<sup>31</sup> At Toronto, [Pursue STEM](#) is an outreach program that encourages and supports Black students interested in science, technology, engineering, and math. Harvard is expanding diversity in programming through enhanced [mentorship programs](#).<sup>32</sup> McMaster is [seeking to correct underrepresentation](#) in STEM research, bringing together Ontario-based scholars who self-identify as Black, Indigenous, and/or 2SLGBTQIA+ on fully funded research scholarships.<sup>33</sup> Purdue University trustees formed an [Equity Task Force](#) to increase the number of Black faculty, students, and staff at Purdue and to ensure that they “can fully embrace all that Purdue has to offer.”<sup>34</sup> This includes a goal of raising [\\$75 million to support STEM initiatives](#), along with an emerging leaders and scholars program, hiring 40 new faculty in public health, veterinary medicine, urban agriculture, and African American studies.<sup>35</sup> Purdue partners with Morgan State and Tuskegee University in STEM-related research and undergraduate studies.

In all six institutions, the university’s senior administration is focused on meeting federal funders’ requirements for research data and researchers’ needs for research data. Interviewees raised related priorities, such as information security and information integrity. In all cases, they are focused on ensuring the institution’s approach is sustainable, including necessary expertise, infrastructure, and services. Research libraries are actively engaged in many of these endeavors as institutional partners. The libraries’ roles are documented more extensively in the following section.

For further details and examples specific to each institution, please consult the institutional briefings in the Appendix.

## **Research Libraries’ Alignment with Institutional Themes**

The prospect of more strongly supporting STEM within the university’s learning and research enterprise is widely and well recognized by research libraries and is already being actively pursued by those we visited. For some, STEM has always or long been a focus; for others, there remains a need to balance STEM growth with continued support to humanities and social sciences. It was clear that all disciplines, not just STEM, are increasingly digitally based and technology-enabled—if not technology-driven.



The research libraries we visited have distinctive governance structures: some have faculty advisory groups; all are members of institutional bodies such as deans', provost's, and/or research councils. All of the library leaders report to the provost and all of the libraries have an academic mission, although Purdue was unique in being a named faculty, the Libraries and School of Information Studies.

In all cases, library leaders are fostering library positioning and alignment with university STEM initiatives or growth strategies. In terms of overarching alignment we found that library leaders were:

- **Nurturing strategic campus relationships and creating or seizing opportunities for partnership or co-governance**—While relationships with faculty deans and the university's senior administrators have always been essential to effective leadership, the library is consciously strengthening ties, both formal and informal, with the VP Research and the CTO/CIO. Some institutions have formed new units or new committees that foster partnership and collaboration across these three areas of research support services.

The research libraries proactively seek partnership opportunities and are also opportunistic. Several are building on their strength in GIS data and expanding data-analysis services in partnership with other units (Purdue, Toronto, and Northwestern). Along with partnerships based on expertise, such as Toronto's [Centre for Research Innovation and Support](#),<sup>36</sup> the libraries partner in providing space, such as the [Health Innovation Clinic](#) at McMaster.<sup>37</sup> University-wide leadership in research includes Purdue's [Institute for Information Literacy](#)<sup>38</sup> that brings together researchers, educators, and stakeholders to investigate information-literacy challenges and develop new information-literacy models to navigate the world of information. The MIT Library partners with the School of Science on a \$2,500 [Prize for Open Data](#),<sup>39</sup> as well as taking a lead on open knowledge through its [Center for Research on Equitable and Open Scholarship](#).<sup>40</sup> These clusters of research library expertise reach beyond the institution into national and international realms, such as the [Biodiversity Heritage Library](#) at Harvard,<sup>41</sup> the [Digital Research Alliance of Canada](#),<sup>42</sup> and the [US National Academies of Sciences, Engineering, and Medicine](#).<sup>43</sup>

In terms of research and interdisciplinary research initiatives, these research libraries are:

- **Championing open science and a global knowledge commons**—Several of the libraries advocate that the global trend toward open science/open research befits the university mission, advancing humanity's knowledge. Concurrently, however, the library allays common STEM researcher concerns—such as those

related to data sensitivity, ownership, or control, or to the perceived loss of prestige or impact with open publishing. For example, for human subject data, the library sees nuance and looks to support “as open as possible but restricted as necessary.” In 2020, [MIT Libraries stated](#) as one of its six key commitments, “We will prioritize an open scholarship agenda that accelerates the progress of science, promotes equity and inclusion across disciplines, and reduces the marginalization of scholars and scholarship from disadvantaged communities.”<sup>44</sup>

- **Sponsoring campus-wide services that promote research/researcher visibility**—For example, the [Digital Research Commons at McMaster](#)<sup>45</sup> is a pilot partnership with governance shared among High Performance Computing, IT, and the McMaster Library, but it was conceived and spearheaded by, is based in, and is most strongly resourced by the library. This may extend to specific roles related to persistent identifiers (PIDs) or other metadata, and spearheading campus-wide research information management (RIM) integration efforts.
- **Delivering essential data tools, services, and advice**—The libraries are advocating to faculties that research data management (RDM) is important to quality research, reproducibility, and funder requirements. And the libraries are positioning themselves to provide expertise and support to enable better RDM (such as DM planning, curation, deposit, etc.), enabling compliance with funder policy.
- **Engaging in their own STEM-relevant or STEM-supporting research**—Furthermore, the research libraries’ faculty and staff contribute to the research and innovation mission through their own research and in strategic partnerships with other units and institutions. Research library faculty across all sites mentioned examples of publishing on such topics as digital information and scientific communication, data and information ethics, dis- and mis-information (particularly in its digital form), and in specific fields of data-intensive research, such as geospatial information, biometrics, and biodiversity.
- **Actively recruiting or strengthening library-based digital research capacity and expertise**—The libraries are defining and securing new functional positions supporting a variety of research-support roles, including RDM, systematic reviews, the supply of data sets, training on the use of research tools, and more. Harvard’s Countway Library, for example, has reallocated human resources to support open science—including expertise in applying unique identifiers, bibliometrics, selecting and accessing data repositories, and the use of software, code, and scripts. STEM-aligning libraries recognize that this shift

requires deep expertise across the research life cycle, knowledge of tools and research environments, and credible outreach to other departments and research teams.

- **Managing expectations and working on strategies for scaling and sustaining STEM roles**—The libraries are increasingly aware that demand for their STEM services could easily outstrip their current and likely future capacity. The most commonly cited example here was knowledge-synthesis services, a.k.a. systematic reviews. Demand has been “overwhelming” librarians in the medical sciences, and is beginning to extend to other STEM disciplines. In response, some are developing methods of triage and/or criteria for screening demand. The library might, for example, look to engage in research projects in which they foresee generalizable gains, such as reusable tools.

In the realm of STEM teaching and learning (T&L), library leaders were actively:

- **Integrating library areas of teaching into core course curricula**—Library faculty design and deliver whole courses and classes within courses in addition to offering specially scheduled seminars and workshops. There is also some broadening of course topics beyond information literacy and data skills to cover research methods, environments, ethics, and communication. Purdue’s [course list](#)<sup>46</sup> and [certificates](#)<sup>47</sup> exemplify this.
- **Instilling skills for better science communications**—A teaching and learning specialist at McMaster noted their aim to teach/instill “how to be a practicing scientist and citizen of the world” through the ability to access, evaluate, and communicate science. This desire to influence students’ ability to both assess and meaningfully communicate about science, contributing to humanity’s advancement, was echoed at MIT and other institutions.
- **Identifying cross-overs between T&L and research**—One example would be providing an open-to-all makerspace, such as the [Thode Makerspace at McMaster](#),<sup>48</sup> which, through an active outreach program, is known to students, staff, and faculty and supports classroom uses, research project uses, and popular (nonacademic) uses as well.
- **Developing strategies to showcase STEM content in distinctive collections**—This may entail scientific themes for exhibits or bringing distinctive library holdings into the classroom. In the case of McMaster, a position of “teaching and learning collections strategist” focuses on this strategic alignment.

These strategies are understood to challenge more traditional structural models, such as the liaison model, the functional model, and the distinctions traditionally drawn between them. Liaison roles are both broadening (for example, moving beyond subject-based search skills to include software and RDM skills) and generalizing (for example, a formerly specialist librarian matched with one faculty may now be part of a cluster, serving a number of faculties). With increases in the broad and often collective licensing of digital resources and in just-in-time delivery, there may be an accompanying reduction in subject-based selection and collection development for liaison librarians. These changes can create tensions.

It was clear that skills and talent needs are changing. Every university will have a distinct labor-relations context; among the six we visited, we could discern no single approach to the credentials that will best assure a vibrant, evolving, and ultimately successful library in a digital STEM-forward university. Is there a requirement for a science-based PhD as well as an MLIS—or just one or the other? Does the increasingly technical, data-driven, and interdisciplinary nature of research call for increased recruitment from computer science to assure sufficient tech skills, or is the hiring for technical library positions better served by seeking softer attributes, such as curiosity, creativity, communication skills, learning capacity, flexibility, problem solving, and foresight capacity? Does the definition of “librarian” (usually an ALA-accredited MLIS or equivalent) need to evolve? Will local unions/faculty associations support such evolution? And ultimately, are the I-schools recognizing the need to attract more digital/science-background students, and the need for library school curricula to keep pace with the rapidly changing information environment?

We had conversations about these questions at all six institutions, and understood it to be a source of both frustration and new resolve. The library is adapting—indeed, must adapt—its workforce to allow the library to be perceived as vital to a STEM strength.

## Highlights

### *Harvard Data Commons and Regulated Data Strategy*

The [Harvard Data Commons](#) and the Regulated Data Strategy are collaborative projects involving schools across Harvard, sponsored by the vice provost for research, the vice president and CIO, and the vice president for the Harvard Library and university librarian. The Harvard Data Commons aims to improve the researcher's experience through services and infrastructure that facilitate the flow of research data from research computing environments to management, publication, discovery, and preservation environments. The Regulated Data Strategy is focused on a current high need: management of regulated and contractual data resources in an increasingly complex regulatory environment requiring appropriate levels of security and access. Librarians are partners with research and IT colleagues in working groups of both projects.

### *Massachusetts Institute of Technology (MIT) Office of Research Data and Computing*

[MIT's Office of Research Data and Computing \(ORCD\)](#) is a newly formed group whose mission is to “make research computing ubiquitous across campus in ways that are more impactful than ever and, wherever we can, fun and enjoyable!” ORCD's focus is on campus-wide resources for research and teaching use by anybody in the MIT community. The office coordinates closely with the MIT Libraries, among others. The libraries are represented on the [advisory committee for ORCD](#) and library resources and workshops are frequently promoted via the [ORCD newsletters](#).

### *McMaster Digital Research Commons Pilot*

At McMaster University, a three-year [Digital Research Commons Pilot](#) (DRCP) aims to build a more connected, capable, and researcher-focused approach to digital research support. This will improve access to systems, services, software, and training for researchers across the institution. It will also allow service providers and support units to collaboratively identify support gaps and develop complementary and shared services that meet diverse needs across campus. The pilot is co-sponsored and co-governed by the vice-president research, the chief technology officer, and the university librarian, and the library hosts the team.

### *Northwestern Research-Data Management and Services*

The Northwestern Office of Research, Information Technology, University Libraries, Feinberg School of Medicine IT, and Galter Health Sciences Library created a joint initiative to support research-data management and services. Two working groups were formed in January 2023. The Data Management and Sharing Security working group will create a rubric for data-storage evaluation, identify security concerns, and develop guidelines for proper redaction of research data. The group will also address handling of sensitive information and revise existing data-retention policies. The Data Management Governance working group will develop an action plan with prioritized goals to better coordinate research-data management services on campus. This includes identifying deliverables, milestones, and responsible parties; determining the necessary support and resources; and creating timelines.

### *Purdue Data Mine Learning Community*

[The Data Mine](#) at Purdue is a learning and research-based community that introduces students to data-science concepts and equips them to create solutions to real-world problems. The Data Mine is part of Purdue University's [Integrative Data Science Initiative](#), designed to train students across all majors with the data literacy needed to succeed in a data-driven world. Libraries and School of Information Studies faculty teach in the Data Mine learning community and in related [certificate programs](#).

### *University of Toronto Centre for Research and Innovation Support*

At University of Toronto, the [Centre for Research and Innovation Support](#) (CRIS), is a partnership, launched by the [Division of the Vice-President, Research & Innovation](#), the [University of Toronto Libraries](#) and [Information Technology Services](#). Acting as a hub, it provides a range of resources and services to strengthen the research enterprise across all three campuses. Embedded in the Gerstein Science Information Centre, CRIS is advised by a large committee chaired by the VPRISI and on which the university chief librarian is a key member.

## Conclusion

These examples serve as data points for further discussion and perhaps a more systematic approach to understanding research libraries' impact broadly, and individual research libraries' impact specifically within their institutional context. Our assumptions about what may cause or underpin variation—such as the benefit of direct or indirect access to research funding, centralization vs. decentralization, private vs. public institutions, well-funded vs. less-well-funded institutions—have neither been proven nor disproven: our observations instead point to these assumptions being worth challenging. Such distinctions did not seem to be the most important factors.

Instead, we found commonality. The common thread across all six institutions is the intention to be preeminent and to solve grand challenges—almost always through interdisciplinary research and learning, and focused on sustainability. Effective positioning of the research library in this shared context requires trusting stakeholder relationships, significant political savviness, and making difficult choices—resulting in credibility. Common constraints to alignment include structural and perceptual challenges in talent acquisition, inclusion, and retention; disagreements on trade-offs between traditional and emerging priorities, such as which types of collections to prioritize; and having the necessary resources to invest in research-support services and related partnerships.

Our hope is that this summary and the six institutional briefings provide research libraries and their institutional partners with examples that can serve their own priorities and initiatives.

## Harvard University—Observations

In-person site visit in Cambridge, Massachusetts, on October 7, 2022, with the following Harvard personnel:

- Martha Whitehead, Vice President for the Harvard Library and University Librarian and Roy E. Larsen Librarian for the Faculty of Arts and Sciences
- Joseph deVeer, Project Manager and Museum Liaison, Ernst Mayr Library (member of the Science Council)
- Franziska Frey, Chief of Staff and Senior Advisor for University Library Strategy, Planning, and Assessment
- Elizabeth Kirk, Associate University Librarian for Scholarly Resources and Services
- Scott Lapinski, Associate Director, Publishing and Data Services, Countway Library of Medicine
- Michael Leach, Associate Director of Research, Instruction, and Collection Resources, Cabot Science Library (member of the Science Council)
- Elaine Martin, Director and Chief Administrative Officer, Countway Library of Medicine
- Amy S. Van Epps, Director of Sciences and Engineering Services, Cabot Science Library

## The University and STEM

Harvard is widely known for its liberal arts and science undergraduate education through the Harvard College, for such professional programs as law and business, and for its primordial role in medicine and public health. Notably, enrollment in Harvard College undergraduate programs is rising in the sciences, and this year's highest enrollment first-year course is in statistics. Harvard aims to excel in all disciplines and functions decentrally. It does not typically undertake institution-wide strategic planning.

The provost's current priorities include several in the sciences. A focus on preeminence in life sciences includes building the [Chan Zuckerberg Biohub network](#),<sup>49</sup> the [Landmark Bio](#)<sup>50</sup> and regional partnerships (such as [MassCPR](#),<sup>51</sup> the Massachusetts Consortium on Pathogen Readiness). Many academic initiatives cut across the institution, with two of the newest being the [Kempner Institute for the Study of Natural and Artificial Intelligence](#)<sup>52</sup> and the [Salata Institute for Climate and Sustainability](#).<sup>53</sup>



A commitment to interdisciplinary initiatives includes the requirement for Harvard College students to take at least one course in each of the three main divisions—Arts and Humanities; Social Sciences; and Science, Engineering, and Applied Science (SEAS). Many of the [cross-school initiatives](#)<sup>54</sup> address pressing social and intellectual needs. The work of the [Institute for Quantitative Social Science \(IQSS\)](#)<sup>55</sup> is of interest as the home of Dataverse.

## **The Library and Its Alignment with the University and STEM**

The Harvard Library (28 libraries) works collaboratively across the university and as a member of the provost's team, including specifically with the vice provost for research (VPR) and the vice president & chief information officer (VPCIO). The library is advised by the Harvard Library Board (acting at a fiduciary level), a faculty advisory council, and a visiting committee overseen by the Harvard Board of Overseers. Specific areas of collaboration with the VPR and VPCIO focus on data (research-data management) and open scholarship. The library perspective emphasizes its vision for advancing open knowledge—diversify and expand access to knowledge, enhance discovery and engagement, and preserve for the future. For example, there is a new position of university scholarly communications officer, overseeing the library's Open Scholarship and Research Data Services department, who will partner with the university research computing officer (IT) and a new university research data officer (IT and VPR). Jointly, the VPCIO, the VPR, and the vice president (VP) for Harvard Library are sponsoring a project focusing on regulated data strategy, which will be a primary focus for the university research data officer.

The three VPs are also sponsoring the Harvard Data Commons, a work in progress to automate the flow of research data from research-computing environments to management, publication, discovery, and preservation environments. The VPR is engaging in a review of corporate relationships of interest to both the VPCIO and the VP for Harvard Library. An example of a significant corporate relationship is the Harvard Data Science Initiative, a partnership with Elsevier that enables large-scale data mining. The library is taking the lead in interpreting and supporting the August 25, 2022, [US Office of Science and Technology Policy \(OSTP\) memo](#)<sup>56</sup> on ensuring immediate open access to federally funded research.

Given the decentralized nature of Harvard, where the Faculty of Arts and Sciences, nine professional schools (such as Harvard Business School), and the Radcliffe Institute for Advanced Study run independently (including their libraries), the Harvard Library and the school library directors form a Library Leadership Team of more than 30 people in senior administrative roles, and together work to align strategic priorities across Harvard where possible. Many of the disciplines, especially those that are data-intensive, are self-sufficient in terms of computing, software

development, and data management. Identifying pipelines to new faculty can be challenging. Even in a climate of plenty, there are disparities in endowments and some impose legal restrictions on current-day use. These disparities can lead to interpretations that certain disciplines are privileged over others.

In general, the interviewees reported that the Harvard University community is committed to and proud of its libraries. They noted that “good news” library stories that surface at the university level are more often in the humanities and social sciences (HSS) than in the sciences because of the extraordinary collections strengths in HSS, and there are communications efforts underway to emphasize the library’s support for all disciplines.

There is a transition to a “just in time” model in STEM; whereas, in the humanities, “just in case” collecting persists. The latter tends to be well supported by endowments, although legal restrictions within many agreements can constrain the use of funds. There is work underway to ensure better terms in new donor agreements. The dependency on digital content for STEM research is acutely tied to journals and research data. The library has collective collection agreements and robust resource sharing initiatives (such as Borrow Direct) with other universities to increase access.

Even before the COVID-19 pandemic, Harvard Library operated as “digital first,” although that does not mean “digital only”—they will obtain anything requested by faculty. At the Cabot Science Library the staff characterized the collection as “adequate” with a desire to improve; at the Science, Engineering, and Applied Sciences (SEAS) library the physical footprint is mainly study space with an exceptional collection on the ethical and equity needs of STEM; while the Harvard College and Harvard Medical School collections are generally considered to be “outstanding.” Harvard does not have a “big deal” with Elsevier or with Wiley and Springer Nature. Collaborative collecting within Harvard has been in place for a long time. For example, the Cabot Science Library and the medical school library cooperate on licensing some nontraditional scientific research resources, such as libraries of MRI scans.

The Harvard Library no longer pays article-processing charges (APCs) to open-access (OA) publications. However, there is a scholarly communication librarian focusing on publishing innovation and the Harvard Library fosters diamond OA, providing both services and platforms. Green OA is supported by DASH, their institutional repository, and by Dataverse for data deposit.

According to the members of the Harvard Science Library Council, the research ecosystem is centered in the discipline and in the individual departments. Given the difficulty in scaling to meet all possible needs of the Faculty of Science, the science

library primarily engages with graduate students on data-skills development, such as data carpentries and formulating data-management plans. The Ernst Mayr Library and Museum of Comparative Zoology is focused on archival collections and global collaboration through the Biodiversity Heritage Library of Natural History. The staff shared their desire to offer and engage in other STEM-based services to support teaching and the research cycle. Examples include increasing support for undergraduate students, working with faculty in their curriculum design to support learning throughout the program, providing support throughout the research life cycle, and collaborating with high-performance computing. Staff noted immediate challenges with open positions. A science background is required for STEM librarian positions, giving the library credibility and helping to build faculty relationships.

The Countway Library of Medicine supports Harvard Medical School, the School of Dental Medicine, the School of Public Health, and affiliated hospitals. Countway Library is a separate administrative entity with its own budget but it is part of the university-wide Harvard Library system and depends on Harvard Library departments for some core library functions. Likewise, the libraries of the Harvard Business School, Harvard Law School, and other professional schools do not report to the VP for Harvard Library. As mentioned, these separate entities participate on the Library Leadership Team, chaired by the VP for Harvard Library and university librarian and Roy E. Larsen Librarian for the Faculty of Arts and Sciences, Martha Whitehead.

With its world leadership in medical education and research, Harvard's Countway Library of Medicine sees itself as helping "translate science into care" and aims to be a student hub for the three schools it serves. It offers outreach and support services, including resource fairs; workshops on Zotero, databases, data visualization, presentation preparation, elevator-pitch preparation, and the scholarly communication process; study resources, such as an Anatomage table; pet therapy sessions; a café; and a community garden. The Harvard Medical School has a strategic plan, and as a result, Countway Library has one too. The library does not have a governing body. The library leadership has regular check-ins with the school's leadership. Structurally the library is focused on internal alignment by specifically engaging with departments and research labs to meet National Institutes of Health (NIH) mandates and to support grants and research, and the library is part of the school's research data management working group. Recently the library reallocated human resources to support open science—including expertise in applying unique identifiers, bibliometrics, selecting and accessing data repositories, and use of software, code, and scripts. This shift has required deeper expertise in the research life cycle, knowledge of tools and the art of the clinical environment, and credible outreach to the departments and research teams.

## Massachusetts Institute of Technology (MIT)—Observations

In-person site visit in Cambridge, Massachusetts, on September 19, 2022, with the following MIT personnel:

- Chris Bourg, Director of Libraries
- Sue Kriegsman, Deputy Director, Center for Research on Equitable and Open Scholarship (CREOS), MIT Libraries
- Ye Li, Chemistry and Chemical Engineering, Materials Science and Engineering Librarian
- Christine Malinowski, Research Data Librarian
- Amy Nurnberger, Program Head, Data Management Services, and Interim Head, Data and Specialized Services, MIT Libraries
- Rebecca Saxe, Associate Dean, School of Science, and Associate Dean and Jarve Professor, Brain and Cognitive Sciences
- Daniel Sheehan, Program Head, GIS and Statistical Software Services, MIT Libraries
- Ece Turnator, Humanities and Digital Scholarship Librarian

### The Institute and STEM

The mission of MIT is to advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and the world in the 21st century. STEM has always been a core strength of the institute, which is widely considered the top STEM university in the US, if not the world. MIT has only 12,000 students, of which 61 percent are graduate students. MIT's 3,500 international students come from 135 countries. In [2022–2023](#),<sup>57</sup> 57 percent of undergraduates and 22 percent of graduate students self-identified as members of one or more US minority groups. Women accounted for 48 percent of undergraduates and 39 percent of graduate students. MIT has [five schools](#),<sup>58</sup> and a new College of Computing. While students do take pre-med courses MIT does not offer a school of medicine.

During the interviews, a fundamental MIT strength was expressed to be its focus on both the science of STEM and its societal benefits and implications. Because engineering serves society, MIT has a long-standing pedagogical philosophy to ensure that scientific/technical education is broadened by mandatory “classic” humanities courses. (Humanities research at MIT, however, tends to focus on the digital humanities.)

The new College of Computing reflects an institutional strategy to infuse computing knowledge into and across all disciplines. The premise is that all research is digital/computational and the aim is to find “common ground” that will foster and advance the computational application to help solve the most important research questions in any field. An ambitious hiring strategy will see 50 new faculty appointments—25 computer science faculty and 25 “bilinguals” who are, for example, both computer scientists and research biologists.

As described by the interviewees, the MIT culture is academically competitive and technologically “DIY” insofar as research teams default to developing local, bespoke solutions to serve the needs of individual projects. Therefore, generic or reusable tools, policy-driven standards, or broadly applicable guidance on best practices are somewhat counter to the prevailing culture.

While a general increase in researchers’ interest in open science and research-data management (RDM) has resulted from funders’ policies, interviewees felt that widespread uptake was better served by encouraging open-science practices, rather than by implementing top-down policies that require them. That said, there have been changes made in some departments’ promotion and tenure (P&T) policies, for example, to include data management. But because MIT is very decentralized, departments vary widely in their P&T policies.

The School of Science (one of the five schools served by the MIT Libraries and a strategic partner) has focused on such priorities as investment in climate science, investment in the intersection of life sciences and other fields, and strengthening inclusion in the scientific endeavor. The associate dean of the School of Science noted disciplinary differences in openness to data management and to open science: physicists, for example, have long engaged in massive international collaborations with data and preprint sharing, and therefore see the problem as largely solved; life scientists express “anxiety” related to such factors as capitalization and patents, human-subject data protection, and national-security restrictions.

The School of Science and the MIT Libraries recently partnered on a \$2,500 prize for open data. They were pleased to receive 75 applications, with representation from all five MIT schools as well as the College of Computing. This is seen as an example of “encouraging” change (as mentioned above) and opportunity to build community with a body of researchers who feel that providing open access to their research is a contribution to the advancement of humankind.

The associate dean ascribed a strategic role to the library within the mission of the School of Science, and noted that the library must continue to articulate both the value of open science and of the library's role in it. The library can both facilitate and point to trusted resources. Given the DIY culture, there is researcher reticence about data sharing, standards adoption (such as findable, accessible, interoperable, and reusable (FAIR) data and persistent identifiers (PIDs)), and shared tools and best practices; in fact, many researchers do not naturally perceive the library as necessary. In this setting, the library can offer solutions in partnership with other core services on campus to translate what is possible into a pragmatic norm, particularly with a focus on equity and understanding that there is no consensus on open access. One opportunity is to work with the new [Office of Research Computing and Data](#),<sup>59</sup> which is meant to address research-computing infrastructure and service inequities across MIT and to close the gap in needs among grad students to be taught both data management and software engineering. In closing, the associate dean reflected that open science/scholarship may be at a tipping point and that it befits the MIT "brand."

## **The Library and Its Alignment with the Institutes and STEM**

The MIT Libraries report to the provost. The libraries envision a world where enduring, abundant, equitable, and meaningful access to information serves to empower and inspire humanity. The MIT Libraries aspire to advance knowledge by providing a trusted foundation for the generation, dissemination, use, and preservation of, and creative engagement with, information, in support of the MIT mission and so it can be brought to bear on the world's great challenges and in the cause of social justice.

In this context, the MIT Libraries operate under a "digital first" approach because that is what their students and researchers expect. While they do hold "distinctive collections," they consider themselves to be relatively unencumbered by traditional large-scale print collections.

A 2016 institute-wide Task Force on the Future of Libraries envisaged a future where "knowledge and data...can be exploited and analyzed by humans, machines, and algorithms."<sup>60</sup> In 2020, the libraries published "[MIT Libraries Vision: A New Urgency](#)"<sup>61</sup> that articulated six key commitments:

- We commit to being a digital-first library; and will expedite our efforts to maximize digital access to content and services.
- We will prioritize an open scholarship agenda that accelerates the progress of science, promotes equity and inclusion across disciplines, and reduces the marginalization of scholars and scholarship from disadvantaged communities.
- We will invest in staff, services, and tools to support data-intensive and computational research and learning.

- We will focus our physical collections, services, and spaces on an essential core—a portfolio of exceptional quality and singular relevance to MIT research and teaching, whose value cannot be meaningfully replicated in a digital or online context.
- We will create an environment to advance, support, and sustain equity, diversity, inclusivity, accessibility, and social justice initiatives through our work and within our organization.
- We will exercise bold leadership in defining a model for research libraries in an unpredictable future.

In support of MIT's increasing focus on open science and broad computational services, the libraries provide a range of training and support services, including data management, citation management, writing tools, statistical services, geographic information systems (GIS), software carpentries, ORCID, etc. The libraries express their historical value in stewarding data after the research is done, and additionally today in instilling FAIR and CARE (collective benefit, authority to control, responsibility, and ethics) practices earlier in the research life cycle; as a consequence, the libraries would like to see more disciplinary specificity in available published FAIR and CARE guidance.

The Research Data Index is a pilot project run by the MIT Libraries' Digital Library Services directorate, and is an index pointing to open data produced at MIT. It is in the pilot phase right now with three research centers participating.

While assistance with data-management plans (DMPs) has historically been an entry point for working with researchers, library-based RDM experts are increasingly involved in setting up research environments and protocols. This aligns with the goal of collaborating with the College of Computing.

While the libraries aspire to influence and assist RDM practices across the whole institute's research enterprise, they do not feel they have the resources to meet demand, were it to be expressed at scale. Therefore, they will seek to actively partner with the new Office of Research Computing and Data. That office sees the need to train and actively engage with researchers throughout their time at MIT, and sees the library as "bridge, coordinator, integrator."

The Center for Research on Equitable and Open Scholarship (CREOS) is a research center within the MIT Libraries, focused on conducting and supporting basic research on open and equitable scholarship—for example, investigating how disparate communities can participate in scholarship with minimal bias or barriers. CREOS aligns with MIT's long-standing commitment to innovation, entrepreneurship, and open educational resources.

## McMaster University—Observations

In-person site visit in Hamilton, Ontario, on January 26, 2023, with the following McMaster personnel:

- Vivian Lewis, University Librarian
- Jay Brodeur, Associate Director, Digital Scholarship Services, McMaster Library
- Richard Godsmark, Deputy Chief Technology Officer
- Helen Kula, Associate University Librarian, Teaching and Learning
- Jennifer McKinnell, Director, Health Sciences Library
- Karen Mossman, Vice-President, Research
- Chris Nicol, Human Resources Manager, McMaster Library
- Lynne Serviss, Associate University Librarian, User Services and Community Engagement
- Abeer Siddiqui, Learning Support Librarian, School of Interdisciplinary Science
- Wade Wyckoff, Associate University Librarian, Distinctive, Legacy, and Digital Heritage Collections

### The University and STEM

Over the last 130 years, McMaster has evolved from a small liberal arts college to a research-intensive institution with a world-renowned medical school and tremendous strengths in science and engineering. Today McMaster is a STEM-heavy, decentralized public university. According to senior administrators it is the most decentralized Canadian university based on the UniForum data. It has more than 60 research centers and institutes.<sup>62</sup>

McMaster has five strategic priorities: inclusive excellence; teaching and learning; research and scholarship; engaging local, national, Indigenous, and global communities; and operational excellence.<sup>63</sup> The university has 32,119 undergraduates (mostly in science and engineering) and 5,251 graduate students (with the largest numbers enrolled in engineering and health sciences), for a total student population of 37,370. McMaster has 997 full-time instructional faculty members.<sup>64</sup> Rankings and research dollars per faculty are tracked closely.

The university recently increased its focus on interdisciplinary learning and research. For instance, in most of the undergraduate programs in science, engineering, and health sciences, large numbers of the professors have cross-faculty appointments, with increasing engagement with the social sciences, business, and humanities. The MacPherson Institute for Leadership, Innovation, and Excellence in Teaching and the related Digital Learning Framework are integral to all undergraduate programs, with the focus now on developing related policies. Even with the extensive



decentralization, McMaster has a Teaching and Learning Advisory Group at the university level, and has recently rolled out a Digital Research Commons, hosted by the University Library in close collaboration with other campus units.

Interdisciplinary research teams are strongly encouraged by the Canadian Tri-Agency and other funders' requirements for cross-disciplinary expertise to conduct research on big, complex issues. An example of this is the Global Nexus for Pandemics and Biological Threats, which includes interdisciplinary experts, cross-sector players, and global partners with a shared commitment to anticipate, rapidly detect, address, and neutralize future pandemics and biological threats. In 2022 it launched a [program](#) that seeks to correct underrepresentation in STEM research settings.<sup>65</sup>

## **The Library and Its Alignment with the University and STEM**

McMaster's University Library (which includes Mills Library, Thode Library, Innis Library, the Russell Research Archives, and the Sherman Centre for Digital Scholarship) partners with the separately administered Health Sciences Library to support the university's research and teaching needs. The university librarian reports to the provost and the Health Sciences Library director reports to the dean of the Health Sciences Faculty. Given the focus on interdisciplinary research and cross-faculty teaching appointments, the main library and Health Sciences Library work to leverage each other's strengths and to reduce duplication of efforts.

While the roots of the McMaster's libraries are in the humanities, as reflected in the legacy archival and circulating print collections, the focus on STEM is evident in the libraries' services. In 2019, McMaster Library held a [year of programming](#) celebrating the ways in which the library supports research, teaching, and learning related to STEM.<sup>66</sup> The library has the [Thode Makerspace](#), which serves all students, staff, and faculty.<sup>67</sup>

The University Library is the lead partner on the campus's new [Digital Research Commons](#),<sup>68</sup> which is a pilot partnership with governance shared among the High Performance Computing Centre (HPCC), IT, and the library. Core services include research-data management practices, depositing data institutionally and more broadly (Dataverse Borealis, PubMed), data visualization, bibliometrics and research impact, digital scholarship tools and ethics, and IT security. The Research Commons serves the whole university.

McMaster Library provides the Lewis & Ruth Sherman Centre for Digital Scholarship, which reports jointly to the university librarian and the dean of the Humanities Faculty. The library also supports McMaster Experts, the university's remote infrastructure management (RIM) system that is focused on systems integration, provides a data warehouse, and integrates with ORCID. (McMaster Experts is a

partnership between the University Library, Office of Research, and central IT, with the library managing the day-to-day operations.)

There is an explicit strategic direction to align the teaching and learning services with the broader university strategy, and the University Library is represented on the Teaching and Learning Advisory Group. There is a collections strategist who works with the teaching and learning librarians to bring distinctive collections into the classroom and has a focus on open educational resources and open licenses. The teaching and learning librarians design and deliver courses, seminars, and classes within the curriculum on how to be a practicing scientist and citizen of the world through the ability to access, evaluate, and communicate science. Their work is integrated into the undergraduate and graduate curriculum—both of which are research intensive.

The Health Sciences library offers a series of services for its faculty and students, including bibliometrics publications, bibliographies, and an emerging collection on Indigenous healthcare. They are actively engaged in conducting systematic reviews/knowledge-synthesis work. If the request is a consultation, they will help the researcher put a module together but do not do the work themselves. This model addresses the difficulty with sustainability and avoids getting into clerical tasks. Through a partnership with the Business School, the Health Sciences Library hosts a Health Innovation Clinic that engages entrepreneurs and students.

Both library organizations are focused on aligning with university-wide initiatives and strategic intentions. Strategic partnerships with administrative peers—such as the chief technology officer, the vice-president for research, and faculty deans—are critical for aligning resource allocations to mission-critical needs. The University Library recognizes that it must focus and, therefore, aligns its staff and collections resource allocations with demonstrated demand.

There are challenges beyond the financial ones. For example, finding people with new skill sets—particularly attracting individuals with the necessary digital skills and recruiting and retaining a diversity of lived experiences, all in a highly competitive labor market. The libraries are eager to attract more colleagues with deep subject expertise in STEM fields (biochemistry, genetic research, engineering, etc.) who can comfortably straddle subject and functional roles. It is hard to find the staff and difficult to pay for them. What is clear is that the ethos requires people who are exceptional communicators, deeply collaborative, and exemplary problem-solvers.

## Northwestern University—Observations

In-person site visit in Evanston, Illinois, on November 28, 2022, with the following Northwestern personnel:

- Xuemao Wang, Charles Deering McCormick University Librarian and Dean of Libraries
- Milan Mrksich, Vice President for Research and Henry Wade Rogers Professor
- Sean Reynolds, Vice President for Information Technology and Chief Information Officer
- 16 library colleagues with assorted STEM-related roles, including the deputy director of the Galter Health Sciences Library

### The University and STEM

Northwestern University is a private university in a suburb of Chicago. It attracted \$893 million in sponsored research funding in 2021 and looks to increase that to \$1 billion.<sup>69</sup> While Northwestern has a significant amount of sponsored research, it is focused on faculty preeminence—particularly the number of faculty who are members of the National Academies of Sciences, Engineering, and Medicine. Northwestern prides itself on its STEM strength and its interdisciplinarity. The student body comprises more than 14,000 graduate students and more than 8,000 undergraduates.<sup>70</sup> The undergraduate student body is predominantly white (52 percent) with significant representation of Asian Americans/Pacific Islanders (24 percent), Hispanics (17 percent), and Blacks (12 percent).<sup>71</sup>

The university librarian and dean of libraries reports to the provost and is a peer with the vice president of research (VPR) and the chief information officer (CIO), both of which are key roles in the university's STEM initiatives. Based on conversations with the VPR and the CIO, the role of the library in supporting the university's research is emerging and they are excited by the new library leadership.

The VPR leads the development and implementation of university-wide strategic plans in support of high-impact research efforts. He is focused on increasing funding and rankings and on the preeminence of faculty (for example, the percentage who are named to the National Academies, the number of private-public partnerships and innovations, and intellectual property). The CIO's organization provides both high-performance computing platforms and related services to the university's research community.

All research funding is managed by the provost's office with no funding provided directly to the library for its role in research support. There is a Sponsored Research Workflow group that includes every school's associate dean for research.

The university is looking to increase resources, including STEM, in the following areas:

- Grow research funding support across all schools
- Grow research in key intellectual and interdisciplinary areas
- Invest in research infrastructure
- Enhance innovation and entrepreneurship through building and sustaining a vibrant ecosystem

When asked how this might play out for their work with the library, the VPR's and CIO's responses started with stating that the research library is best positioned to manage data long-term while the expertise in providing services would reside in the CIO organization. As the conversation continued, other opportunities for collaboration on a university-wide strategy were noted. These included research-data management and scaling services to support the institution particularly with regard to federal research funding, working together to reduce researcher administrative burden, and offering training and research support to faculty throughout the research workflow. Within this context, specific collaborative opportunities mentioned were scaling research support for data science and artificial intelligence (such as machine learning), and strengthening the interdisciplinary research centers.

## **The Library and Its Alignment with the University and STEM**

The library's new leader, Xuemao Wang, started in September 2022 and began a re-envisioning process for the libraries in early 2023. Based on a nimble and agile approach that creates a shared vision with campus stakeholders, Wang seeks to further align the library with the university and to set priorities and an annual implementation plan. His focus is on building on the existing strengths of traditional services, being selective about newer areas for investment such as digital scholarship and research data management. He is also focusing on working in partnership across campus academic units and repositioning the library as a true partner in the research enterprise and as a catalyst in promoting cross-disciplinary research.

The university librarian and dean of libraries works with, but does not manage, the director of the Health Sciences Library. The Health Sciences Library reports into the Medical School. Between the two organizations, there is a significant focus on STEM-related services and a growing investment in STEM-related expertise. In high demand are data-management services (analysis, platform, and planning), geographic information systems (GIS) expertise (research and teaching), and health sciences (and increasingly non-health sciences) systematic reviews. Both libraries (University Library and Health Sciences Library) are considering strategies to scale these services beyond the collaborations that already are in place.

Data-management planning is a collaborative effort with the High-Performance Computing group within the CIO's office. There is a local repository (Arch) but it has storage-size limitations and therefore Northwestern now also works with Dryad. A cross-university group (VPR, library dean, CIO) is preparing a university-wide strategy to meet the requirements set by the recent NIH research-data policy. Two working groups—one on workflow policy and the other on infrastructure policy—will set the institutional policy and practice. GIS services are in high demand and are offered across the university and initial collaboration is beginning with the new Geography Department.

The health sciences committee on systematic reviews triages the requests it receives and noted that requests are “skyrocketing.” To meet this demand, new perspectives will be assessed, particularly the use of computational methods that increase the ability for researchers and students to do this work on their own.

The August 2022 US Office of Science and Technology Policy (OSTP) guidance on [“Ensuring Free, Immediate, and Equitable Access to Federally Funded Research”](#)<sup>72</sup> provides an opportunity for rethinking research funding of the library. Currently the library does not receive direct funding from research grants unless the faculty or staff are written into the grant. It is an opportunity to further communicate the impact the library faculty have on the research including grant-funding success, and their role in the research. At present, when the library becomes involved in research, some other work necessarily has to stop. There is some funding for new positions in research-data management and digital scholarship, but there have also been significant cuts for the last three years, particularly in the collections budget. This has limited the ability to grow STEM collections while maintaining current collections emphases, such as unique collections in African studies, transportation, and music. With the new university librarian's leadership, the library will look to make the case for deeper investment in supporting sponsored research partnerships, and in the new roles and information resources to do so.

STEM collaborations beyond the library are both historically strong and evolving. The Health Sciences Library faculty and staff work closely with the other members of the Association of Academic Health Sciences Libraries (AAHSL) and the Medical Library Association, particularly on bibliometrics. There hasn't been a STEM focus within the Big Ten Academic Alliance (BTAA), although topically it has been covered in other working groups, such as the assessment working group. The BTAA was felt to be another opportunity to support STEM at scale.

## Purdue University—Observations

In-person site visit in West Lafayette, Indiana, on November 29, 2022, with the following Purdue personnel:

- Beth McNeil, Dean of Libraries and School of Information Studies, Esther Ellis Norton Professor of Library Science
- Jay Akridge, Then Provost and Executive Vice President for Academic Affairs and Diversity
- Sarah Huber, Associate Professor, Science and Engineering Libraries
- Theresa Mayer, Then Executive Vice President for Research and Partnerships
- Pete Pascuzzi, Associate Professor, Science and Engineering Libraries
- Dave Zwicky, Associate Professor, Science and Engineering Libraries

### The University and STEM

Purdue is a land-grant state university with about 80 departments (counting schools within colleges) and more than 50,000 students (more than 10,000 of whom are grad students).<sup>73</sup> Purdue excels in aeronautics, agriculture, engineering, and veterinary medicine. There is no medical school, though Purdue has strong nursing and other health science programs. Purdue research is approaching \$550 million per year<sup>74</sup> using more than 400 research labs. Tuition has been frozen for the past 11 years, but growth has continued, spurred by increased enrollment.<sup>75</sup> Purdue is an active member of the Big Ten Academic Alliance.

Purdue's strategic direction is focused on the pillars of:

- Affordability and accessibility
- Online education
- STEM leadership
- World-changing research
- Transformative education<sup>76</sup>

Purdue has always been STEM focused. The provost shared that the applications to STEM programs have “exploded” in recent years, and they have therefore added 7,000 students in STEM as part of their ongoing growth. But the growth in STEM enrollment was not at the expense or to the detriment of non-STEM programs. While the funding “follows the students” (STEM receives more), Purdue has also added 40 new liberal arts faculty positions to support the STEM programs core courses. Liberal arts also work to align with STEM; for example, one can do a BA in philosophy focused on AI ethics. Likewise, the Business School has emphasized data science/data analytics as core.

Purdue is committed to diversity, equity, and inclusion—specifically in advancing its STEM investments. The university trustees formed a Diversity and STEM Equity Task Force to increase the number of Black faculty, students, and staff at Purdue. This includes a goal of raising \$75 million to support STEM initiatives, along with an emerging leaders and scholars program and hiring 40 new faculty in public health, veterinary medicine, urban agriculture, and African American studies.<sup>77</sup> Purdue partners with Morgan State and Tuskegee University in STEM-related research and undergraduate studies.

## **The Library and Its Alignment with the University and STEM**

The provost noted that, a few years ago, the Board had questioned the investment in the library and took a “deep look.” As a result, the library was “repositioned” as a college like all the others, headed by a dean, and rebranded as Libraries and School of Information Studies. Librarians have faculty status, with ranks of assistant, associate, and full professor and are assessed—like any faculty—on their teaching, research, and service. This allows the library to flag these activities as contributions to the teaching and research missions of the university. While the library does not currently offer a major, it does offer certificates in digital humanities and geospatial information science,<sup>78</sup> and may soon offer a minor in information studies.

The provost felt the library was now in a strong position for growth and expansion; he cited as an example the Undergraduate Research Office, which is housed in the library, as a valued and growing role. He noted that the library also contributes to data-science initiatives, which include the “wildly successful” Data Mine, an interdisciplinary living-learning community open to all programs.

The provost expressed hope that the library will continue to elevate its roles in data science, the undergraduate research space, and in supporting changes within academic publishing (citing the ongoing challenge of “big deal” subscriptions, the shift to open access without embargo, and open educational resources). He felt that the library was poised to gain more visibility through these strategic emphases not only with students but with the university president and Board of Trustees. The provost is highly supportive of library initiatives that point to it being “More than books” (a tagline the library uses), such as moving two-thirds of the print collection from one of the libraries to an off-site storage facility. The provost noted that the Purdue Libraries Dean’s Advisory Council (donors) is deeply committed to the library and its central role at the university.

The vice president for research and partnerships (VPRP) reports to the president directly and is a peer of the provost. In her role, she works with the schools’ Associate Deans for Research Group, who officially report to the Dean’s Council. The VPRP’s focus is on compliance, pre- and post-award help, and industry partnerships. The

associate deans for research are also focused on ensuring Purdue's rankings remain competitive as measured by Association of American Universities (AAU) metrics, including citations, and peer discussions on access and affordability, the value proposition of higher education, and data to support quantitative research. The VPRP cited concerns about the US Office of Science and Technology Policy August 2022 memo<sup>79</sup> as presenting "another unfunded mandate" without clarity about the federal government's role in paying for and sustaining the required infrastructure. She also expressed concerns about open science as it relates to sensitive data. Opportunities for the library's contributions in STEM surfaced regarding unstructured data, FAIR (findable, accessible, interoperable, and reusable) data training, and expertise in data integrity and usefulness—not only in terms of platforms, such as research-output repositories, but also in terms of teaching and research. The library is perceived as critical to connecting with the students and faculty—providing greater flexibility to deploy resources from a central service—essentially adding value through services and expertise. The VPRP expressed interest in an institutional approach to research services that would include the treasurer, the Office of Research, the CIO, and the library. Following a discussion about scale, she was supportive of exploring a collaboration among the Big Ten to consider developing a research platform (repositories, research data) with the library taking the lead on services.

The Libraries and School of Information Studies reports to the provost and participates in the VPRP's Associate Deans for Research Group. The library aligns its priorities with the university's strategic pillars—receiving all funding from the president and working closely with the provost. The library has a faculty advisory committee that advises on resources, and is interested in re-establishing a graduate and undergraduate advisory council as well. The teaching and learning group is collaborating with the Council for Undergraduate Deans to help even out the student experience on campus and build greater understanding of what the library offers. The Libraries and School of Information Studies external alumni board is very supportive and a significant source of donations. Along with the president and provost, the dean of libraries is very active in the Big Ten Academic Alliance.

There are 35 tenured/tenure-track faculty librarians, plus 7 clinical faculty librarians and archivists, who conduct research, teach, and are embedded in other schools, and 140 library staff in total (plus student employees). Searches for library faculty are underway for FY 2024 in areas of STEM and digital humanities.

The Libraries and School of Information Studies offers a dozen courses that are part of other schools' curricula, certificate programs, or independently offered.<sup>80</sup> Among other topics, these include courses in data visualization (for example, chemistry, bioinformatics) and geographic information sciences. Four faculty members are



regularly engaged in the College of Engineering. Data-science courses are not core introductory curriculum yet, though that is likely. Demand for systematic reviews is growing (involving five librarians and attracting funding); it is now being taught in health sciences as a credit course. The Libraries' Institute for Information Literacy at Purdue brings together researchers, educators, and stakeholders to investigate information literacy challenges and develop new information literacy models to navigate the perilous world of information. The institute creates a community of information literacy researchers whose work enables people to successfully navigate today's information environment. Information literacy-related courses are designed to assist undergraduates in thinking critically and evaluating research information.

PURR—Purdue University Research Repository—was a partnership with the Research Office and IT when it started over 10 years ago; now it is provided by the Purdue University Libraries and the Office of the VPRP with support from additional campus partners. PURR is not intended for big data sets, nor was long-term access and preservation guaranteed beyond 10 years. Some current holdings are therefore reaching the end of the initial retention commitment, and the library repository managers will need to consider what merits retention.

Engagement with the library by other schools is characterized as still uneven: some colleges are more likely than others to be open to library roles within their research and data science. However, some library faculty do have courtesy appointments in campus academic departments and teach in their programs.

The primary challenges of the Libraries and School of Information Studies are the need for more space, the capacity to add position lines, recruiting in general, and finding metadata talent.

## University of Toronto—Observations

In-person site visit in Toronto, Ontario, on January 25, 2023, with the following University of Toronto personnel:

- Larry Alford, University Chief Librarian
- Laura Anderson, Director for Strategic Initiatives, University Libraries
- Michael Cassabon, Director of Advancement, University Libraries
- Darlene Chow, Human Resources Director, University Libraries
- Leah Cowen, Professor and Vice-President, Research and Innovation, and Strategic Initiatives
- Sarah Forbes, Science Liaison Librarian, Scholarly Communications Librarian
- Marcel Fortin, Head, Map and Data Library and Advisor on Research Data Management, Data Sciences, and Digital Research
- Angela Hamilton, Chief Librarian, University of Toronto Scarborough Library
- Julie Hannaford, Deputy Chief Librarian
- Angela Henshilwood, Head, Engineering and Computer Science Library
- Sian Meikle, Associate Chief Librarian for Digital Strategies and Technology
- Glen Morales, Chief Administrative Officer, University Libraries
- Cheryl Regehr, Vice-President and Provost
- Mindy Thuna, Associate Chief Librarian for Science Research and Information
- Caitlin Tillman, Associate Chief Librarian for Collections and Materials Management
- Nazi Torabi, Collections Coordinator, Sciences, University Libraries

## The University and STEM

University of Toronto (U of T) is Canada's largest and top-ranked university, with an enrollment of over 97,000 students and attracting over \$1.45 billion in research funding.<sup>81</sup> U of T's engineering programs rank number one in Canada and among the top fifteen in the world. The university attracts as much funding from the National Institutes of Health as it does from the Canadian Institutes of Health Research (CIHR).

The university is actively encouraging recruitment of, and proactively fostering leadership and inclusion for, students from underrepresented groups—including women and IBPOC/BIPOC—through programs such as [Pursue STEM](#), launched in 2021, an outreach program that encourages and supports Black students interested in science, technology, engineering and math.<sup>82</sup> U of T currently has about 27,000 international students, of which almost 80% are from Asia/Pacific, and the vast majority of those are from China.<sup>83</sup>

The vice-president, research and innovation, and strategic initiatives (VPRISI) noted that excellence and impact are considered in a nuanced manner at U of T. The university looks to infuse research into their educational mission, and is fostering interdisciplinary clusters of research through such mechanisms as [Institutional Strategic Initiatives](#) (ISI) with an objective to better address grand challenges.<sup>84</sup> The [Centre for Research and Innovation Support](#) (CRIS), in which the library is a partner, provides a range of resources and services to strengthen the research enterprise across all three campuses.<sup>85</sup> Embedded in the Gerstein Science Information Centre, CRIS is advised by a large committee chaired by the VPRISI and on which the university chief librarian is a key member. In addition, the VPRISI, associate VP research, CIO, and university chief librarian meet monthly.

The [Data Sciences Institute](#) (DSI), launched in 2021, aims to unify data-sciences research, training, and partnerships across the university, including its three campuses, affiliated research institutes, and external partners.<sup>86</sup> The DSI defines data sciences as “the science of collecting, manipulating, storing, visualizing, learning from, and extracting useful information from data in a reproducible, fair, and ethical way.”<sup>87</sup> The work to promote and integrate research-data management (RDM)—and library roles and expertise within RDM—within the DSI is ongoing.

## **The Library and Its Alignment with the University and STEM**

The U of T Library operates as a valued shared service under a stable, faculties-funded financial model. The provost stated that the library is “central, core, and critical to what we do.” She cited key roles for the library in all areas of the university mission: (1) support to students’ skills and well-being, such as the “personal librarian” initiative and instructional integration into the curriculum; (2) support to teaching, such as the Syllabus Service; and (3) support to research, such as the provision of large data sets, data specialists, licensed software services and supports, and access to digital resources. The provost posited that, while subject expertise resides best with faculty, there is a critical need for “skills generalists” who have mastery over digital research methodologies and tools.

The management team noted that, with so many disciplines at U of T, it can be difficult to serve all areas well. They observed that “STEM” is not a singular concept; for example, some disciplines **are** data scientists (such as engineering), while others **rely on** data scientists (such as medicine). The scale and complexity of research communities is challenging, and demand for some services (such as data services) risks overwhelming capacity. To ensure outreach and foster alignment, the deputy chief librarian and the associate chief librarian for science research and information meet annually with the chairs of each of the disciplines. STEM research as well as

STEM teaching and learning increasingly entail interdisciplinarity, which challenges the siloed faculty structures and the traditional liaison model wherein every discipline has an assigned liaison librarian. The library has moved to a clustered model for the subject specialists, and believes this to be encouraging more collaboration among team members. Complementing and augmenting the liaison clusters, functional specialists within the central library system provide in-depth expertise in a range of areas, such as RDM, digital publishing, knowledge synthesis, copyright, and preservation.

In discussing collecting, the management team noted that U of T STEM researchers tend to assume that “discovery equals delivery”—the library will have or will get everything they request. The library is, by necessity, shifting funds away from one-time monographic purchasing towards subscription-based acquiring, and working consortially to scale back collections expenditures and manage down print collections.

Other challenges mentioned—though not limited to STEM—include that the university is requesting all shared services, including the libraries, to develop five-year financial plans, and there is concern that required application of UniForum measures is not well capturing the range and value of library work.

The activity of knowledge synthesis is seeing increased and broadened demand, now extending beyond the health disciplines to other STEM areas, as well as to the social sciences. The expansion has placed further strain on their ability to meet overall demand. It is therefore considered a collaboration rather than a service. We were told that the “parameters are clear”; for example, the principal investigator (PI) must meet with the librarian; there is a triage system; respective roles are spelled out; and the librarian can turn down or step away from the project at any time.

Library data services are well supported (10 positions and growing, with 3 new shared positions) and well respected across campus, and it is “just expected” that the library will be at the table for any discussion of RDM issues. A library RDM expert has co-lead with the head of CRIS the campus work to draft U of T’s institutional RDM strategy, a requirement of the new [Tri-Agency RDM Policy](#).<sup>88</sup> This spring a text and data mining conference will be hosted by the library; this is felt to be likely to help with the library’s positioning and profile in the context of the university-wide Data Sciences Institute.

The Scarborough and Mississauga campuses are different: the faculties are less siloed and researchers tend to look to the library to foster interdisciplinarity and to play a role of integrator. They are also much smaller, making their ability to scale more manageable. Functional specialties such as RDM are less developed at the suburban campuses, and there is reliance on the central library's functional services.

When asked how success is measured, responses from the management team included:

- Repeat use (such as Knowledge Synthesis service)
- Administrators, researchers, and professors recommending the library to students
- Inclusion of the library in strategic conversations; the library being viewed as a vital partner in initiatives
- Uptake on digital services (for example, use of resources such as data sets)
- Resource allocation to the library
- Advancement successes (donations earmarked for the library)

The individuals in STEM-related library positions with whom we met felt that there was still much work to do to better promote and support open science, interdisciplinarity, the adoption of FAIR and CARE in RDM practices, and the adoption of persistent identifiers (PIDs), such as ORCID identifiers or digital object identifiers (DOIs). They felt it would be helpful to reframe the available research supports across the research life cycle. While recognizing the need for the library to show flexibility, they suggested that scaling deposit of data or publications, engagement in knowledge synthesis, and uptake of PIDs could be helped by role clarity and setting clear parameters (for example, “You do these three things; we will do these (other) things.”).

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