abstract: Measuring research impact has become a nearly ubiquitous facet of scholarly communication. At the University of Minnesota Medical School, new administrative directives have directly tied impact metrics to faculty assessment, promotion, and tenure. In this paper, I describe a platform for the analysis and visualization of research impact that was developed in the University of Minnesota Libraries specifically to support these directives. The implementation of that platform, named Manifold, has required not only major technological resources but also new investments in user education. The libraries’ experience with Manifold offers a case study of the changing roles academic librarians increasingly face in managing expectations around research impact metrics.

Introduction and Context

It is difficult to ignore the integral role that research impact metrics now play in scholarly communication. With increased competition for research funding and tightened departmental budgets at institutions across the country, such measurements as publication totals, citation counts, downloads, views, and the $h$-index, a metric based on a scholar’s most cited articles and the number of citations the articles have received, have burrowed their way into many levels of institutional assessment. Not limited to administrators alone, these metrics have increasingly become the focus of attention from individual researchers as well. Scholars find themselves under more pressure than ever before to distinguish themselves from their peers with quick, quantifiable evidence of the value of their work.
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These trends are felt directly and indirectly across academe, and there is growing concern over the dangers they might bring. The smattering of impact metrics available today has made it easier to quickly compare scholars’ careers. However, many authors and university administrators misunderstand the extent to which these metrics can be reliably used as comprehensive indicators of scholastic achievement. In practice, these measures are far from perfect because comparisons across disciplines and individuals, upon which they are premised, are rarely absolute. Cultural dimensions of scholarship, such as how often researchers publish on average, the extent to which researchers cite one another inside and outside the same area of study, and the natural ebb and flow of researchers’ careers, can differ dramatically across disciplines and among individuals.\textsuperscript{1} When these differences are ignored, predating the assessment of research impact upon the assumption that these metrics are universally applicable can have dangerous consequences.

As a profession, academic librarianship is keenly aware of these issues and can play a pivotal role in challenging perspectives about impact metrics in the context of scholarly communication. The dangers of misuse are evident at all levels of academe and have begun to leave a mark on the practices of researchers themselves, many of whom still lack a sophisticated understanding of what these numbers actually reflect. Under mounting pressure from administrators and peers, it is easy for researchers to succumb to the power that these measures can hold over advancement in their careers. Even more alarming is the extent to which this power has increasingly transformed into a currency of advancement with perpetually higher stakes, tied ever more tightly to tenure, promotion, and research funding.

At the University of Minnesota, Twin Cities, the implications of these trends have become particularly noticeable over the past few years in correlation with intensified administrative focus on institutional assessment. The catalyst for this focus has been a process of strategic planning at all levels of campus administration as the university endeavors to position itself more prominently in international research and education. Guided by the Board of Regents’ vision that the university “will be preeminent in solving the grand challenges of a diverse and changing world,”\textsuperscript{2} the administration has launched initiatives that aim to recruit, retain, and recognize excellence in research and learning. Individually, all colleges, units, and divisions at the university have developed their own strategic initiatives in alignment with these goals.

In this process, the Medical School has received special attention, with pressure building from both the university administration as well as the Minnesota Legislature to invest significant resources in revitalizing the scholarship of its faculty.\textsuperscript{3} In partial response to this challenge, the Medical School appointed in February 2014 a new dean who was charged with measuring Medical School scholarship, bolstering its international reputation as a center of world-class education and research, and raising its national rankings.\textsuperscript{4} The new dean addressed these challenges in part through a program called the Scholarship Metrics Initiative, which outlines new faculty and departmental requirements for demonstrating research output and impact, and ties those guidelines into new expectations about promotion, tenure, and review.\textsuperscript{5}
The Medical School’s research impact Metrics Initiative is built on the assumption that scholarly contribution to the life sciences and physical sciences—and consequently the impact and value of a scholar’s research—is best evidenced by a history of prolific publication in peer-reviewed journals. To raise the university’s prominence in international research and education, therefore, the Medical School should have a strong record of scholarship demonstrating the breadth of its research. In alignment with this vision, the Medical School administration implemented new standards requiring all Medical School faculty to publish at least one peer-reviewed article each calendar year. To ensure compliance, the administration tracks faculty through analytics about how often they publish, the journals in which they publish, and the extent to which those publications are cited. Additionally, publications in which the faculty member is listed as first or last author receive extra weight, reflecting administrative belief that such positions denote significant contributions to research, regardless of discipline.

The Metrics Initiative was implemented in many ways. The first of these was the creation of the “Wall of Scholarship” in the fall of 2014, an installation of engraved plaques near the Medical School. The wall showcases the front pages of publications on which Medical School faculty are listed as either first or last author and that have received at least 1,000 citations in two out of three citation indexes (Scopus, Web of Science, and Google Scholar). The intent behind this project is to recognize top-achieving researchers (as measured by citations), thereby encouraging and inspiring scholarly achievement. However, early controversy emerged around the meaning of first or last authorship across different disciplines as well as the reasoning for the 1,000-citation threshold, given artificial differences in citation data across the databases considered. With more stringent requirements around publications and the pressure of public recognition for faculty performance, antagonism toward administrative expectations began to surface among the Medical School faculty.

Sensitive to these concerns, the University of Minnesota Libraries early on became closely involved in the Metrics Initiative. Having provided the data analyses to determine eligible faculty and publications for the Wall of Scholarship, the libraries suddenly became a focus of interest to the Medical School administration. Initially, this increased visibility was welcome. Shortly before, the libraries had created a new position specifically to provide informatics support for the health sciences, and the Medical School’s requests provided an opportunity to leverage this new expertise. However, as controversy around the initiative and its motivations intensified, so did administrative demands on the libraries’ resources. To enforce the new faculty publication requirements and to track compliance, Medical School administration handed down a new request that thrust the libraries into an unanticipated role: the libraries would be called upon to provide regularly updated reports of publications and impact metrics for all full-time, paid Medical School faculty for administrative review.

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Given the size and complexity of the Medical School, these new requests represented a colossal endeavor. To provide programmatic support for 2,200 researchers across nearly 30 departments, the libraries would need to invest in developing a technological and service infrastructure scalable to meet the Medical School’s needs for the long term. Over the course of a year, this infrastructure culminated in a project called Manifold, an online system custom-built in direct response to the Medical School’s needs to analyze research impact. At a systems level, Manifold automates the harvesting of publication data and analytics on faculty productivity. Through an online interface, the system dynamically generates faculty profiles with downloadable data about the impact of their research. At a services level, Manifold has also positioned the University Libraries in the midst of university-wide discussions about the measuring of research impact across disciplines.

In this paper, I will explore the implementation of Manifold at the University of Minnesota as a case study for one response to the increasingly important role academic librarians now play in matters of research impact and institutional assessment. I will describe Manifold in brief from a technological perspective. More importantly, I will investigate how the University Libraries’ work with Manifold provides a model for the changing role of libraries in scholarly communication.

Manifold: Supporting Impact Metrics in the Medical School

The libraries’ initial involvement in the Wall of Scholarship project in the months preceding its inaugural installation in October 2014 represented an important change in visibility. Recognized for their role as stewards of faculty scholarship, the libraries began to play a critical role in supporting administrative directives around measuring the impact of scholars’ research. However, as the visibility of the libraries’ contribution grew, so did the complexity of requests. Seeing the success of the Wall of Scholarship, the Medical School expanded its requests to include full reports for all Medical School faculty listing their recent publications, citation counts for those publications, and measures of research impact, including publication numbers, \( h \)-index, and other metrics. These reports would need updating every three months to be used directly in assessment processes, and faculty would be expected to make sure that the information in the reports was accurate.

The result of these demands was Manifold, a system born directly to automate the generation of these reports for the long term. Manifold is at once an analytics platform and a Web-accessible interface for reporting scholarship and research impact. Written in a popular Web scripting language called PHP, the system uses automated processes to harvest publication data through the Scopus API (application program interface), an interface that allows software programs to communicate with one another via code. Manifold ingests data into a database management system called MySQL, calculates metrics, and displays the data and metrics in report-like “profiles.” These processes occur once every three months, and as a result, each profile is at most a snapshot of Scopus data up to the point of update. (More details about the technical specifications of Manifold, along with its complete open-source code, are provided elsewhere.)
Manifold produces these profiles for individual faculty members, departments, and custom subsets of faculty hand-selected across departments. Each profile is composed of a collection of common modules as illustrated in the example profile in Figure 1. At the top of each profile, the top-cited publications by the faculty member or department are listed, each linking back to the original Scopus record. Below this, another module lists publications by the profiled scholar chronologically, filtered by the range of calendar years specified by the user. This list includes publications automatically harvested from Scopus, but faculty also have the option of importing additional publications directly from PubMed, an archive of life science journals maintained by the National Library of Medicine, when those publications are not indexed by Scopus. The PubMed import process requires verification through an e-mail automatically sent to the subject of the profile into which the import is requested. In total, these data can be entered into a spreadsheet file for further analysis or exported into the required Medical School curriculum vitae (CV) citation format.

From a high-level perspective, this functionality is not unique. Several existing researcher networking platforms already generate publication profiles and standard research impact metrics in this way. These platforms include VIVO, created by Cornell University in Ithaca, New York; Elsevier’s SciVal; and SciENcv (Science Experts Network Curriculum Vitae), developed by the National Center for Biotechnology Information. Early discussions with the Medical School weighed the advantages of buying into an existing platform versus building a new one to customize functionality. However, several considerations demonstrated that a homegrown solution would be necessary for both the short and the long term. The first of these was the immediacy, specificity, and unpredictability of the requests. The Medical School administration was eager to have...
data as quickly as possible, and many requests included custom metrics on first and last authorship that existing platforms could not fulfill. Providing such metrics would require returning to the original citation data, which in turn would require a robust technological architecture. Likewise, as administrative requests for additional data and metrics unfolded over time, the libraries would need a responsive technological infrastructure capable of scaling in many directions quickly.

An additional consideration was that the existing resources, which the libraries had hoped would already provide the requested data, were insufficient. In the short term, the libraries had limited staff resources to invest in researching and adopting another platform that might not fulfill all the necessary capabilities. The most important example of this was Elsevier’s SciVal researcher networking platform. The University Libraries host a local instance of SciVal, which itself pulls publication data and impact metrics for most university faculty from Scopus. As a result, the libraries considered SciVal as the first option to respond to administrative requests. However, we quickly discovered that SciVal included only half of all necessary Medical School faculty. For both financial and technical reasons, the remaining faculty could not be integrated into SciVal, meaning that we would need to retrieve data elsewhere. Additionally, the data demands had fallen primarily on one individual, the newly hired informatics specialist (who is also the author of this article). The cumulative effect of the urgency of the administration’s data needs, the rapidity with which those needs escalated, and the isolation to a single individual of the capacity to build out a response to these demands resulted in the conclusion that a custom-built solution would be more suitable for the short term, however ironic that may be in the long term.

When building Manifold as a custom system, thus, the libraries recognized that the final product would need to distinguish itself enough to justify its value over other platforms that may have been available. Manifold combines the power of its data with user education: the system not only provides measures of research impact but also offers visualizations to more adequately contextualize them. These visualizations enable users to responsibly interpret them with an understanding of their limitations. The Medical School never specifically requested these visualizations for the reports; instead, they emerged out of growing concern from faculty as well as library staff that the metrics might be used incorrectly, especially in conjunction with promotion and tenure. The libraries took advantage of this concern as an opportunity to situate the metrics more carefully in a discussion of different cultures of scholarship across different disciplines and departments on campus.

The visualizations built into Manifold include standard statistical plots as well as custom-tailored representations of the research impact metrics. For each profile, these metrics include both traditional measurements, such as the $h$-index, and made-to-order measures like the $h(fl)$-index, a custom calculation of the $h$-index that only considers publications on which the faculty member is listed as first or last author. Other metrics
include total numbers of publications, tallies of first or last author credits, total citation counts, and total first or last author citation figures. For faculty, these metrics are specific to the individual, while for departments and custom subsets of faculty, these metrics are median values across a composite of their scholars. Each departmental profile is accompanied by a box-and-whiskers plot displaying the distribution of the metric across the department (Figure 2). A box-and-whiskers plot summarizes in graphical form the median, upper quartile, lower quartile, upper extreme, and lower extreme values of a distribution. The data are depicted by a box with its edges at the quartile marks, an internal line at the median, and lines—the “whiskers”—extending from the box as far as the upper and lower extreme values. In the case of individual faculty profiles, the person’s position within that distribution is also displayed, making it easy to determine how an individual’s metrics compare to those of his or her colleagues.

Figure 2. A box-and-whiskers plot showing an individual scholar’s research impact metrics and where those metrics fall in the distribution of values for all faculty in the department
Beyond these statistical plots, custom visualizations describe in more detail how the profiled faculty member or department’s scholarship is distributed temporally over the course of a scholar’s career (Figure 3). For instance, one visualization produces a bar chart of a faculty member’s publications ranked in descending order by citation count and colored according to whether the person is listed as first or last author. Another visualization plots publications temporally on the horizontal axis and by citation count on the vertical axis, with publications represented by circles with radii proportional to their total citation count. This visualization makes it easy to identify periods in a faculty member’s career in which he or she published with high frequency and high impact, assuming that impact is approximated by citation counts.

![Figure 3. Additional visualizations are built into each individual faculty profile. Here, one visualization shows citation counts over time, represented by circles, and another visualization shows changes over time in the $h$-index, based on the scholar’s most cited articles and the number of citations the articles have received.](image)

There are many documented limitations of using $h$-index values as a stand-in for impact. Some weaknesses of the $h$-index include its poor sensitivity to career length, quantity of papers published, or different cultures of scholarship across disciplines. While librarians have an awareness of these caveats, the same cannot necessarily be said for researchers and administrators. Consequently, we built additional visualizations into Manifold to address these issues. One visualization provides a line plot showing how a faculty member’s $h$- and $h(fl)$-index have changed over the course of his or her career. At
each year throughout the career, $h$- and $h(f)$-index values are calculated considering only publications authored that year. Although these calculations are heavily biased because they are based on current rather than retrospective citation counts, the visualization offers at least a snapshot of possible inflection points throughout an individual’s history. Additionally, a researcher’s current $h$-index can be interpreted relativistically as the product of the scholar’s career as opposed to interpreted through static comparison with the $h$-index of peers. This helps provide a visual representation of how a researcher’s publication history fits into the context of the discipline’s culture of publishing. Fields in which publication rates run high may exhibit different patterns than those which emphasize publishing less, a difference that was observed across Medical School departments.

In another visualization, a histogram or bar graph displays the range of $h$- and $h(f)$-index values across a faculty member’s department (or the range of the department itself) and the number of faculty in the department with each value. This histogram also displays the relative position of an individual faculty member’s metrics within the distribution, enabling a quick assessment of how the researcher compares with his or her colleagues. A final visualization represents this distribution from a subtly different perspective. In it, faculty members are plotted horizontally by $h$-index and vertically by $h$-citation count—that is, the total of citations to the papers in their $h$-core, those publications that are used to calculate the $h$-index. Each faculty member is represented by a circle, the radius of which is proportional to his or her total (career) publications. In this chart, it is possible to see how scholars with the same $h$-index can vary significantly with respect to their citation counts, how authors with the same citation counts can vary across a wide range of $h$-indexes, and how differences in total number of publications can variably interact with both of these distributions. This visualization attempts to stimulate conversation about the relationship between $h$-index and perceived indicators of impact. If two faculty members have the same $h$-index but differ greatly in their citation and publication counts, for instance, one interpretation might suggest that the $h$-index provides a better stand-in for impact for one scholar than for the other, encouraging a more global consideration of the many dimensions of scholarship.

This capacity for providing context falls well within librarians’ authority of expertise and represents an important shift in perceptions of the role that libraries play in scholarly communication. Cognizant of the concerns of faculty who felt threatened by administrative surveillance, the University Libraries used the Metrics Initiative as an opportunity to support faculty in their need to demonstrate the multifaceted value of their scholarship. At the same time, the novel use of visualization offered a medium for delivering the data specifically requested by the Medical School while also providing subtle user education about the importance of considering context when using research impact metrics.

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Meeting Challenges

In its current form, two years since the libraries’ first discussions with the new Medical School dean in 2014, Manifold has achieved success and stability through the collaborative efforts of many University Libraries staff. Both faculty and administrators now regard the platform as a natural part of assessment. However, implementing Manifold from both a systems and a services perspective posed unanticipated challenges to University Libraries resources that have significantly changed the libraries’ relationship with the Medical School and the campus at large. Each of these challenges, some of which are described here, highlights considerations to be made when implementing a system of comparable magnitude at both technological and service levels within a library context.

At the lowest level, some of the most persistent of these challenges related to Manifold’s technological implementation. Manifold is the complex product of many different components, and as a result, problems in any one of them easily propagate throughout the system. Collectively, the system’s functionality relies on a complex network of interactions between the university’s Office of Human Resources, the libraries’ Web Development unit, and Scopus. As a result, weaknesses in any links between them have negative consequences for the rest.

Some of these challenges originated in new questions about how to best use the libraries’ existing technological resources to provide regular data reports for the impact Metrics Initiative. For example, since these reports would focus exclusively on faculty publications, an early consideration revolved around deciding which database to use as the canonical (and most accurate) source for all publication citation data. As has been previously noted, the University Libraries manage a local paid instance of Elsevier’s SciVal platform, which automatically pulls publication data from Scopus for university faculty. The libraries first considered SciVal as the primary candidate for a data source, but ongoing work with the platform revealed significant shortcomings in using its data for Medical School analytics. In response, Scopus and Web of Science, both of which are databases for which the University Libraries manage subscriptions, were subsequently identified as possible data sources. Both provide extensive coverage for the natural and life sciences, making them appropriate for faculty in the Medical School. Early discussion identified Web of Science as the preferable source because of its more extensive citation data; however, we quickly discovered that automating processes from Web of Science would incur an unexpected cost. Although unlimited use of the API to pull publication data from Scopus was already built into the University Libraries’ institutional contract with Elsevier, pulling data from Web of Science had to be specially authorized at a cost of thousands of dollars. With no special funding available to pay Web of Science for data usage in this capacity, the libraries selected Scopus as the canonical data source.

Once a data source was determined, new problems emerged with respect to inconsistencies in the quality of data provided by Scopus. Some were fairly trivial and easily resolved, including, for instance, misattributions that can be corrected by merging Scopus profiles or submitting an error ticket directly to Elsevier’s Scopus support staff. Other minor inconsistencies consisted of errors in the spelling of an author’s name or affiliation (one comical example is a record with the misspelling “Johns Flopkins University”). However, Manifold also revealed many other problems that are much subtler and demonstrate
high level of attention that must be paid to detail to sustain such a complex system at a high threshold of data quality. In one instance, a faculty member reported that one of his publications listed in Manifold indicated 0 citations, while Scopus reported nearly 300. Upon further investigation, it was discovered that this article existed in two separate records in Scopus: one was the original record, with nearly 300 citations, on which the faculty member was mistakenly not listed as an author. The other was an erratum, correcting the omission, but with 0 citations. Although this discrepancy had a negative effect on the faculty member’s metrics, nothing could be done at the time to link the faculty member’s record with the “correct” citation count because such a manual correction would simply be overridden upon the next data update. Instead, the correction would need to appear in the original Scopus data so that it would propagate forward into Manifold. The resolution to this error involved contacting Scopus support staff to correct the data.

Technical details such as these demonstrated to the libraries that they needed to direct specialized focus and resources that could adequately handle these issues as they arose. Inevitably, as faculty and administrators come across more issues in data quality, the libraries would need staff with the expertise to solve problems. Such expertise would require knowledge of not only the technological infrastructure of Manifold but also the idiosyncrasies of Scopus and the way bibliographic data is stored and organized. As a result, the responsibility of solving such problems could not rest only on developers or librarians alone. New collaborations across information technology staff, informaticists, liaison librarians, and Medical School administrators were required to ensure a smooth implementation of the Manifold system.

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Additional insights and challenges emerged with respect to the interoperability of campus systems necessary for making Manifold possible. One such challenge—and one that was notoriously persistent throughout Manifold’s development—involved inconsistencies in how the university’s Office of Human Resources stored data about faculty. In the first phase of development, Manifold pulled all faculty biographical data, including name, rank, department, and pay status, from a payroll database used in the Medical School based on central Human Resources data. However, this approach had several limitations due to aberrations in how the payroll unit stored these data, leading to significant irritation among faculty who felt incorrectly represented in Manifold. Near the end of development, a combination of carefully automated data queries to the central Human Resources system and subsequent manual editing of any remaining inaccuracies addressed these issues. However, this solution became possible only through new collaborations across departmental lines, including library staff, Medical School administrators, and representatives from Human Resources. Additionally, this problem revealed an important way in which supporting Manifold for the long term meant not
only maintaining its technological foundation but also tapping into the specialized curatorial expertise of staff across the libraries and Medical School.

At a services level, the greatest barriers to implementing Manifold arose broadly from the challenge of managing expectations. Manifold is integrated into a complex web of stakeholders, each with different assumptions and needs about the data it provides. These different expectations have resulted in antagonism between faculty and administrators due to discrepancies between administrative policy and the actual publishing practices of scholars. While the new publishing requirement stated that all Medical School faculty must publish at least one new peer-reviewed paper each calendar year, many scholars received this expectation with hostility. One concern was that it seemed unrealistic to expect clinical faculty, who often have little time for research outside of their obligations to serve their patients, to publish original research on such a schedule. In fact, a large proportion of clinical faculty had never published a paper at all. If they were to publish, they would suddenly need extra support from the libraries to guide them through the process of performing literature reviews, formulating original research proposals, and navigating the myriad complexities of publishing.

For faculty with an existing record of publications, new concerns emerged with respect to identifying appropriate outlets for publishing their research. Some scholars’ papers were published in journals not currently indexed by Scopus, such as many open-source journals, thus making Manifold unable to automatically capture these records. This raised concerns in the libraries that faculty might be incentivized to change their publication practices. To ensure compliance with the stated policy, scholars were suddenly not only required to publish at least once each year but also to make sure that the journals in which they published were indexed by Scopus. Although Scopus is improving its coverage of open-access journals, it remains unclear whether administrative policy could have the long-term effect of discouraging publishing through open-access venues.

Some scholars also dispute the meaning of metrics that measure faculty output by number of first- or last-author papers. While in some disciplines the position of the author’s name serves as an indicator of the researcher’s relative contribution to a scholarly work, this assumption does not apply universally across other disciplines, in which traditions of attribution may differ. For example, some teams of authors choose to list their names alphabetically. The issue is further complicated by recent patterns in which contributors are now sometimes listed as joint first authors, raising questions about how such listings should be attributed for the calculation of metrics based on authorship position. As conventions of author attribution continue to change, Manifold will need to evolve to adequately represent faculty contributions that cannot be inferred from author position alone. Part of this task requires playing an active role in helping researchers understand that Manifold should not be used as a comprehensive record of their scholarship. Instead, scholars can best demonstrate impact by assembling a portfolio of many different indicators specific to their discipline.
As use and development of Manifold continues, managing expectations will be a recurring challenge. In the process, it will be critical to find a proper balance between responding to the needs of the Metrics Initiative and stewarding the data provided in such a way as to ensure that all stakeholders can make reasonable, informed choices in their use of Manifold to compare faculty scholarship.

Reflecting on Successes

The preceding section is only a partial list of problems that have been encountered throughout Manifold’s development. Regardless, it does provide an informative context against which to measure its many successes along the way, some unexpected but valuable. These range widely across Manifold from both systems- and service-level perspectives.

One unexpected outcome of work on Manifold has been the cultivation among the faculty and administration of a more intimate and nuanced familiarity with the University Libraries’ information resources and their limitations. For example, as previously noted, work on Manifold has revealed idiosyncrasies and “dirtiness” in Scopus data, some of which have also been uncovered in the data in SciVal, for which the libraries pay. Although the libraries’ license agreement with Elsevier indicates that a portion of the university’s institutional subscription is specifically devoted to curation of data in SciVal, the libraries have begun to take a closer look at the quality of this curation in light of problems that have been encountered.

The libraries have also had some initial successes in the persistent challenge of managing expectations. As the new scholarship requirements exert pressure on Medical School faculty, many opportunities have emerged to deepen user education around metrics and their meaning, constraints on their interpretation, the comparison of metrics across disciplines, and the changing landscape of scholarship. Ideally, this education will continue to be most effective if it trickles down from the top levels of administration. Early evidence suggests that Medical School administrators have developed a more sophisticated understanding of research impact metrics, their meaning, and their limitations.

For example, at a Medical School faculty assembly one year after the beginning of work on Manifold, a faculty member asked the dean about how h-index values would be used to compare scholars across departments. Although just a few months before the dean might have suggested that such metrics could be used objectively across disciplines, he instead rebutted the question by stating that such metrics cannot be used with complete objectivity because they are incomplete representations of scholarship. His statement rang as a victory in the libraries. Other schools on campus have joined this dialogue as well after multiple presentations of Manifold to other campus deans and department
chairs have been received with fresh excitement, even sparking interest in building out Manifold for faculty in other schools.

At the institutional level, the libraries have experienced increased visibility and participation in campus discussion around measuring the impact of faculty scholarship across disciplines, a trend that has become especially evident through the closer relationship that has developed between the libraries and the Medical School. After a presentation of Manifold to Medical School department chairs, one administrator exclaimed, “Library science isn’t what it used to be anymore!” Individual faculty have also demonstrated a greater interest in better understanding their own research impact and how that impact may be measured, recognizing the libraries as a first point of contact to find answers to their questions. Perhaps most interestingly, beyond the University of Minnesota, librarians at other institutions in the United States and Canada have contacted Manifold’s creator to learn more about its successes and failures as they explore the practical resources needed to build services and platforms for measuring research impact among their own teaching staff. Dialogues like these demonstrate value for libraries, giving evidence of positive impact on faculty and administrators’ perceptions of what libraries can provide. As new opportunities continue to emerge to demonstrate libraries’ expertise in new domains, relationships with campus stakeholders at all levels of discussion around institutional assessment will mature further with time.

The Manifold project evolved out of a new need in the Medical School to which the University Libraries were uniquely poised to respond. In spite of its successes, significant questions remain about its future. Moving forward, careful discussions must be held regarding who holds responsibility for Manifold’s support, development, and sustainability, much of which is yet undefined.

One ongoing discussion has revolved around what programmatic support for Manifold should look like in the immediate and distant future. One aspect of such support is technological, including questions about who will provide the continuous technical maintenance and development necessary to allow the system to grow with time. New needs may come from the Medical School itself, but they may also originate in other colleges and units at the university desiring the system for their own faculty, complete with customizations. In this regard, technological support entails anticipating the variety of needs likely to emerge and implementing the necessary infrastructure. As a first response to this issue, the University Libraries Web Development staff have taken on the responsibility of maintaining Manifold in house and integrating the platform into their existing Web infrastructures. However, this discussion will likely continue for some time, especially with continued uncertainty about the standard architecture that must be put in place to ensure that the system is sustainable into the future. This infrastructure must include a database architecture that allows room for growth across other colleges and other heterogeneous data types as well as the development of the server and API support required to make the data available in customized forms. Another interesting
response being explored is the possibility of building a database of faculty scholarly works housed in the university’s central data warehouse, which would enable any system on campus to interface with those data in a standardized and controlled way.

Questions around necessary resources for technological support are complicated by uncertainty about the future of existing services and platforms at the university, particularly those with the potential to develop functionality overlapping what Manifold provides. Currently, the University of Minnesota maintains and manages a variety of systems, including Academic Analytics, Digital Measures, SciVal, and now Manifold. While these platforms overlap partially in functionality, no single system yet has the capacity to serve all needs at once. Conversations around the advantages and disadvantages of “buy versus build” have focused on the dangers of distributing functionality across many different platforms, each requiring independent specialized support and consequently pigeonholed resources. Although resources might be more efficiently invested in the purchase of existing platforms that provide all the desired services at once, no such platform is expected to emerge in the immediate future. In light of this forecast, a critical consideration about support for Manifold includes maximizing interoperability between systems and striving to minimize duplication of efforts.

Programmatic support is also being considered from a services standpoint. Specifically, the libraries have explored appropriate parameters for a model that distributes technical and service responsibilities between both the libraries and the system’s users. As Manifold continues to mature, there have been increased requests for new uses of the underlying data in the form of custom queries, reports, and analyses. One model of support dedicates technical stewardship of the data in Manifold to the libraries and their Web Development staff, and gives business ownership of Manifold to individual colleges or units. In this model, the expectation is that users of the system, such as the Medical School, will provide the financial and human resources required to utilize the platform for their specific needs, such as hiring programmers to perform custom data analyses as requested. Inevitably, discussions around this model have evoked tensions that must be resolved before responsibilities and resources can be distributed optimally.

A key part of this conversation is uncertainty about how to best balance the need for technological automation with the requirement for manual curation to maintain a high threshold of data quality. The development of Manifold has revealed a wide range of complex issues requiring strong attention to detail to resolve, and finding the balance between the competing needs of automation and quality is integral to determining whether Manifold is sustainable for the long term. At present, this balance is distributed across the staff in the libraries’ Web Development unit, who can respond to data-specific problems that arise in the system, and a triage team who can translate user concerns into functional changes in Manifold. This team includes both librarians and Medical School staff. As questions about Manifold arrive through the Web interface’s contact form, users are funneled to the individual with the expertise to

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...finding the balance between the competing needs of automation and quality is integral to determining whether Manifold is sustainable for the long term.
answer their question. This model draws time from staff who could be supplying other services, however, raising important questions about the libraries’ priorities.

At the highest level of administration, there are also questions about what role the libraries should play in the development of a metrics framework for institutional assessment at the university. In contrast to concerns about the project’s technological sustainability, these questions point to critical considerations about intellectual sustainability. As impact metrics become further integrated into assessment practices, the libraries can play a significant role in educating users about those metrics. For metrics to be responsibly employed, this education must focus on the nuanced ways in which the metrics interact with an already complex landscape of academic scholarship. In addition, the libraries can contribute to campus conversation about how impact can be measured more effectively across other disciplines.

Conclusion

The University of Minnesota Libraries’ work on the Manifold project has served as a litmus test for possible directions in which further campus partnerships might grow. Built to serve a specific need from the Medical School, Manifold began as a prototype and grew into an entire technological platform and opportunity for user education of unanticipated magnitude. While the project has resulted in many positive developments with respect to campus perceptions of the libraries’ expertise, it also has brought with it a wide range of questions, both big and small, about the libraries’ future role on campus that will need to be addressed moving forward.

One of the most important of these questions concerns how the University Libraries should invest their resources in the future. Increasingly, the libraries have a significant role in providing services for research support, ranging from counsel on data management to services for the curation and long-term preservation of research data. With Manifold, the libraries’ services have begun to expand in new directions focusing on education about the role of context and authority in measures of scholarship, helping users see the impact of scholarship from a wider perspective. This transition brings excellent opportunities to advance key initiatives in the field of academic librarianship more broadly. An important and relevant example is information literacy, as described in the Framework for Information Literacy in Higher Education put forth by the Association of College and Research Libraries. This Framework seeks to encourage thoughtful consideration of scholarship as a constructive process. Its value is not captured by simple indicators like the h-index and citation counts, but rather is constructed as a product of scholarly discourse. As services continue to focus on helping users become better stewards of the
information they use in the course of their scholarship, libraries will continue to extend into new domains that show that “library science isn’t what it used to be.”

Manifold provides a useful example of these shifting attitudes toward library science. As new roles continue to emerge in academic librarianship at the intersection of data, technology, and education, more opportunities will form organically out of new partnerships and endeavors in which libraries can demonstrate value in unexpected ways. Perceptions of knowledge and skills under the purview of librarians’ expertise are changing, and these perceptions will mature in subtle, nuanced ways as long as libraries face challenges in new directions.

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