Open Research, Open Engineering, and the Role of the University in Society

Devin R. Berg
ORCID: 0000-0002-1193-3848
Engineering and Technology Department
University of Wisconsin-Stout

Abstract

This is a white paper submitted as part of the joint NIH/NSF-funded event, "Imagining Tomorrow's University: Rethinking scholarship, education, and institutions for an open, networked era", to be held March 8th and 9th in Rosemont, IL. In this paper I present my personal (not my employer's) thoughts and reflections on the role that open research can play in defining the purpose and activities of the university. I have made some specific recommendations on how I believe the public university can recommit and push the boundaries of its role as the creator and promoter of public knowledge. In doing so, serving a vital role to the continued economic, social, and technological development of society. I have also included some thoughts on how this applies specifically to my field of engineering and how a culture of openness and sharing within the engineering community can help drive societal development.

Introduction

The origins, expansion, and evolution of the modern university in the United States are rooted in a variety of philosophical constructs ranging from education of the elite to vocational training and the discovery of new knowledge (Benson and Boyd, 2015; Bok, 2013). However, in a time of constrained university budgets which are not expected to improve for as long as most public universities rely heavily on state funding, many universities are being forced to evaluate their institutional priorities ("Public Research Universities", 2016). For some, particularly state universities subject to the whims of state legislation, this could mean abandoning the pursuit of fundamental or basic knowledge generation in favor of more marketable vocational training models that cater more directly to industry needs. While this mission is in line with the Morrill Act of 1862, the university has evolved since that time to encompass a much greater proportion of the economic development of the country ("Public Research Universities", 2016).

I would argue that despite the challenges faced by institutions today, it is critical for the university to continue to position itself as a center of societal development, economically, technologically, and socially. Additionally, the university should push this model even farther towards positioning itself as the main driver of social and technological innovation. To achieve this, it is necessary to position and market the business of the university, as clearly as possible, as a service provider to the many relevant stakeholders. This can be best accomplished by disseminating and distributing the products of university activities as widely as possible through open access publishing, open research, and open innovation and further, demonstrating the impact that these products have on the local, state, national, and international populations. As others have argued, "open research should be the norm. Knowledge should be a public good (Tennant, 2017)."

The conduct of open research

Conducting open research is an act of assigning value to the work that you are passionately committed to. But not just to the final, polished product of that work, the entirely of it. Up to and including the half-baked ideas, the napkin sketches, the first drafts, and the failures. The dissemination of these artifacts may on occasion comprise an act of humility, but ultimately you are recognizing that each of these items is a piece

of the research process and that even your failures have value in the lessons you learned and the lessons that can be passed on to others.

There are now a multitude of resources available to researchers for the dissemination of research products. Some examples include: GitHub (github.com) and Zenodo (zenodo.org) for code, Open Science Framework (osf.io) for project management with support for a variety of file types, repositories such as engrχiv (engrxiv.org) for manuscripts in progress, and figshare (figshare.com) for data, figures, and a variety of other research products. These tools have made it easier for researchers and institutions to disseminate scholarly output and best ensure that it will be available for public consumption for years to come.

The societal impact of open university research

The spread of open research has the potential to open up the research endeavor to all researchers, regardless of home country or institutional affiliation through ease of access to published works free from the economic limitations of paywalls (Tennant et al., 2016). However, participation in open research need not be a purely altruistic endeavor as it has been found that there are many potential advantages to conducting open dissemination of research products (see Figure 1). For example, open access publishing leads to greater citation count for research articles and thus researchers obtain career benefits under the traditional metrics of academic success (Eysenbach, 2006; Norris et al., 2008; McKiernan et al., 2016; Berg et al., 2016a). Further, the benefits of open research are not strictly limited to open access manuscript publishing. Sharing of code and data as well as other research products can also lead to greater citation counts (Piwowar et al., 2007; Piwowar and Vision, 2013; Vandewalle, 2012).

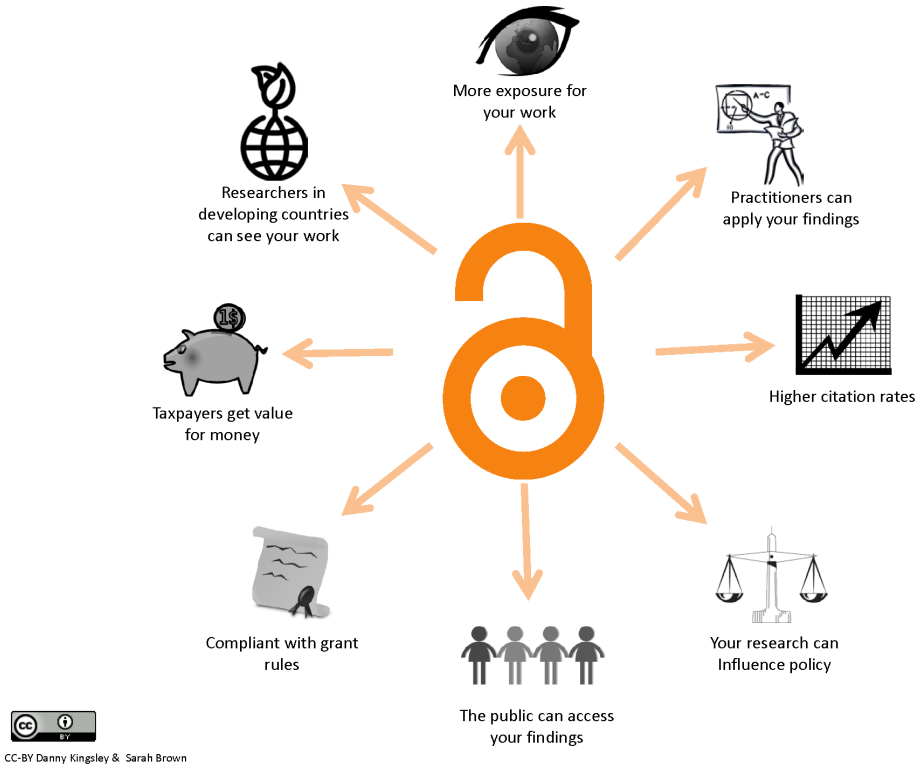

Figure 1: The various benefits of open research. Image: Danny Kingsley and Sarah Brown, 'Why Open Research?' project (whyopenresearch.org).

Looking specifically at my field, engineering, we can also find examples of the positive effects of open knowledge dissemination. According to Chris Ategeka, founder of Health Access Corps, "Patenting a social-impact product hinders scale, ultimately obstructing the maximum impact that particular product would have in the world if it was open source (Goodier, 2016)." Thus, the clear benefit of using open research and development practices is achieving greater impact with your research products. The counter argument to

this is that through patenting, the entrepreneur can more easily market and sell their product in developed markets, which could then increase their ability to affect change by subsidizing their efforts in developing nations. This situation may hold true for products with broad appeal and therefore it is necessary for the inventor to assess which path will produce the greatest impact. Assuming, also, that we encourage and reward *impact*. I would argue that in the majority of scenarios, open dissemination will yield greater impact through simplified adoption and adaptation by others. Especially if the front-end development activities are incentivized in other ways.

My open research path

My first exposure to open science was through a workshop offered by the Open Science Federation (opensciencefederation.com) on open notebook science several years ago. While my efforts at maintaining an open science notebook have dwindled, the workshop did expose me to tools such as figshare, which I still use today. Using these tools in varying capacities, I have committed to making the majority of my research products available openly for consumption, adaptation, and reuse.

Through my own research activities, I have found that the proliferation of open research practices in the field of engineering are sparse and unevenly distributed across disciplines. Researchers doing computational work who have closer ties with computer science have a strong community built around the open source code movement. Additionally, those researchers as well as others whose work aligns closely with physics have access to arXiv (arxiv.org) as an eprint server that has been around since 1991 and thus has significant community support. For other engineering researchers, the specialized resources available to them are more limited.

This realization led me to launch two initiatives in partnership with some like-minded collaborators (Berg, 2016a,b). The first is The Journal of Open Engineering (tjoe.org) which is an open access research journal for engineering emphasizing open dissemination of all engineering research products and created intentionally to be maximally accessible by having no associated fees. The second is engrχiv (engrxiv.org), the eprint server for engineering, developed to help build a community around open research and preprinting for the engineering field. Both of these initiatives are ongoing efforts in the promotion and advancement of conducting open research within the engineering field and we hope that they will help build and maintain a culture of openness and sharing within engineering.

Institutional and cultural challenges

The primary challenges facing those individuals interested in conducting open research generally involve incentivization and restrictive policies maintained by traditional publishers, in addition to the lack of a culture of sharing within the researcher's disciplinary field. First, researchers are often pressured to carefully consider the venue in which they publish their work and to select only those that are *well established* and *high impact*. However, if these venues are not amenable to open research activities such as the posting of preprints, these challenges disincentivize those activities. To remedy this, the research community must continue to pressure publishers to modify their copyright transfer policies. Some progress has already been made in this effort through policies from funding sources such as the Bill & Melinda Gates Foundation[1] and the Wellcome Trust[2] or from research institutions who require deposition in a repository. More information on these policies can be found on the Registry of Open Access Repository Mandates and Policies[3].

Additionally, promotion and tenure requirements typically focus exclusively on the final published manuscript and associated metrics, neglecting other research outputs such as code, data, solid models, etc. and their associated impacts. Some institutions actively discourage making these alternative research products available due to idealistic dreams of future income generation from licensing revenues. However, in reality, the majority of universities lose money through their technology commercialization offices (Valdivia, 2013).

[1] Bill & Melinda Gates Foundation Open Access Policy http://www.gatesfoundation.org/How-We-Work/General-Information/Open-Access-Policy

[2] Wellcome Trust Open Access Policy https://wellcome.ac.uk/funding/managing-grant/open-access-policy

[3] ROARMAP http://roarmap.eprints.org/

Some institutions are instead pursuing alternatives such as EasyAccessIP (easyaccessip.com) which promotes universal knowledge dissemination as a mechanism "to create impact from university research outcomes as opposed to monetary aims." Ultimately it is likely that societal pressure is necessary to push more institutions to participate in such initiatives. For that to happen, the public first needs to be aware of the possible benefits of broad knowledge dissemination and needs to experience those benefits first hand.

Changes needed in institutional policy

As already discussed, there are real career advantages to open access publishing and open dissemination of data, code, or other research products and therefore, for some, the incentives to conduct open research may already be in place. However, for many, citation metrics alone are not enough to ensure success in promotion and tenure and therefore they must play to the norms of their field, department, and institution. Therefore, the institution (and the department) should be looking to institute policy that redefines how we measure success in academia. Some suggestions include focusing less on journal-level metrics and lend greater credibility to article-level metrics. For article-level metrics, go beyond the citation count and looks for other evidence of research impact such as alternative metrics (tweets, blog posts, media coverage) and replication by others. Lastly, look for evidence of broader implications such as economic development, student development, or even lives saved. Encourage your researchers to aim for those broader impacts and value them greater than the publishing of one more paper.

Thinking about what institutions can do to promote open research, create support structures around open dissemination, such as:

- Require research products be made openly available and then support this requirement by having a high-quality institutional repository, supporting other open repositories, and lobbying publishers to modify their copyright policies to promote the publishing of preprints and other products prior to journal submission as well as archiving of final version manuscripts.
- Convert technology commercialization offices into research impact offices. Use these offices as a mechanism for helping researchers broaden their impact through open research best practices, for funding social entrepreneurship, and for advocating these institutional activities at the state, national, and international levels.
- Empower and fund our university libraries to help with open knowledge dissemination. Others have described ways in which research outputs can be pushed public in real time with the support of the library (Brembs, 2017), institutions should promote and support these efforts.
- Educate our undergraduate and graduate students on the importance of open knowledge dissemination and the practices that support it. Create and sponsor workshops that train participants in open source software development, open research dissemination, and global development. Many institutions embrace service learning as a mechanism for greater civic engagement (Bringle and Hatcher, 2009), broaden this approach in a thoughtful and impactful manner. Being careful to ensure that students are learning the right lessons and that partnering communities are not unduly burdened (Berg et al., 2016b).

Summary

In this paper I have briefly outlined my thoughts on how open research practices in the sciences, engineering, and other fields can and should be employed by public universities to position themselves as centers for the creation and broad dissemination of knowledge as a public resource. The opposition to this proposal is immense, particularly in a political climate that devalues an educated populace and with systemic practices and policies that exclusively reward the monetization of any form of intellectual property. Change likely needs to be driven with grass roots initiatives that demonstrate the possible benefits and make it clear that tax dollars could fund these efforts if distributed properly and with accountability. Even still, change is not going to come quickly or inexpensively. But we must try.

References

Benson, M. T. and Boyd, H. R. (2015). The Public University: Recalling Higher Education's Democratic Purpose. *Thought & Action*, http://www.nea.org//home/63441.htm.

Berg, D. R. (2016a). engrXiv Steering Committee. https://osf.io/h6nfz/.

Berg, D. R. (2016b). The Journal of Open Engineering Editorial Board. http://www.tjoe.org/editorialboard.

Berg, D. R., Fleischfresser, L., and Niemeyer, K. E. (2016a). Open publishing in engineering. *The Journal of Open Engineering*, http://www.tjoe.org/article/open-publishing-in-engineering.

Berg, D. R., Lee, T., and Buchanan, E. (2016b). A methodology for exploring, documenting, and improving humanitarian service learning in the university. *Journal of Humanitarian Engineering*, 4(1), DOI: 10.6084/m9.figshare.2758129.v2.

Bok, D. (2013). *Higher Education in America*. Princeton University Press, ISBN: 978-0-691-15914-0.

Brembs, B. (2017). Open Science: Too much talk, too little action. http://bjoern.brembs.net/2017/02/open-science-too-much-talk-too-little-action/.

Bringle, R. G. and Hatcher, J. A. (2009). Innovative practices in service-learning and curricular engagement. *New Directions for Higher Education*, 2009(147):37–46, DOI: 10.1002/he.356.

Eysenbach, G. (2006). Citation advantage of open access articles. *PLoS Biol*, 4(5):e157, DOI: 10.1371/journal.pbio.0040157.

Goodier, R. (2016). The case for open source design in low-cost medical patient transport. https://www.engineeringforchange.org/the-case-for-open-source-design-in-low-cost-medical-patient-transport/.

McKiernan, E. C., Bourne, P. E., Brown, C. T., Buck, S., Kenall, A., Lin, J., McDougall, D., Nosek, B. A., Ram, K., Soderberg, C. K., et al. (2016). How open science helps researchers succeed. *Elife*, 5:e16800, DOI: 10.7554/eLife.16800.

Norris, M., Oppenheim, C., and Rowland, F. (2008). The citation advantage of open-access articles. *Journal of the American Society for Information Science and Technology*, 59(12):1963–1972, DOI: 10.1002/asi.20898.

Piwowar, H. A., Day, R. S., and Fridsma, D. B. (2007). Sharing detailed research data is associated with increased citation rate. *PloS one*, 2(3):e308, DOI: 10.1371/journal.pone.0000308.

Piwowar, H. A. and Vision, T. J. (2013). Data reuse and the open data citation advantage. *PeerJ*, 1:e175, DOI: 10.7717/peerj.175.

"Public Research Universities" (2016). *Public Research Universities: Recommitting to Lincoln's Vision—An Educational Compact for the 21st Century*. American Academy of Arts & Sciences, Cambridge, MA, ISBN: 0-87724-109-0.

Tennant, J. (2017). Ashley Farley of the Gates Foundation: "Knowledge should be a public good.". http://blog.scienceopen.com/2017/01/ashley-farley-of-the-gates-foundation-knowledge-should-be-a-public-good/.

Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., and Hartgerink, C. H. J. (2016). The academic, economic and societal impacts of Open Access: An evidence-based review. *F1000Research*, 5:632, ISSN: 2046-1402, DOI: 10.12688/f1000research.8460.3.

Valdivia, W. D. (2013). University Start-Ups: Critical for Improving Technology Transfer. Technical report, Center for Technology Innovation at Brookings, https://www.brookings.edu/research/university-start-ups-critical-for-improving-technology-transfer/.

Vandewalle, P. (2012). Code sharing is associated with research impact in image processing. *Computing in Science & Engineering*, 14(4):42–47, DOI: 10.1109/MCSE.2012.63.