Building library-based support structures for Open Science

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ABSTRACT

Research institutions meet increasing demands for transparency, accountability, added value and reuse of all aspects of scientific production, from documenting the research process to sharing underlying data to open access to publications. Going beyond admirable slogans about openness there is a clear need for support infrastructures relating to the actual practice of Open Science – describing metadata, archiving datasets and publications and disseminating increasingly interdisciplinary research results. Research libraries, having always been stewards of research institutions' collective knowledge and offering a variety of research support services, are in a unique position to offer future support for Open Science based on the core competencies already existing at the library. This paper describes the process of building a comprehensive research support structure for Open Science at the university library of the Norwegian University of Science and Technology. It shows how the library identified stated, but not necessarily operationalized, university strategies for Open Access and Open Data, and proceeded to strengthen its existing competencies in this area with human resources and a targeted approach to linking the library to the central research infrastructure of the university. This resulted in the library assuming responsibility for new research support services and plans of action for Open Access and Open Data for the whole of NTNU.

KEYWORDS

Open Science; research infrastructure; support services

INTRODUCTION

Research institutions are facing increasing demands for implementing features of Open Science, a concept that has made its way into policy documents and institutional strategies in recent years. This paper describes new developments within the field of Open Science, with a focus on the role of research libraries as facilitators and critical support infrastructure for realising institutional strategies promoting Open Science.

We choose to adopt an inclusive definition of Open Science in this paper: any movement towards increasing transparency, accountability and access in any part of the research life cycle can be included under the Open Science umbrella. A good illustration of what this constitutes comes from Pontika et al (2015), who have made a comprehensive Open Science taxonomy:

Open Science Taxonomy
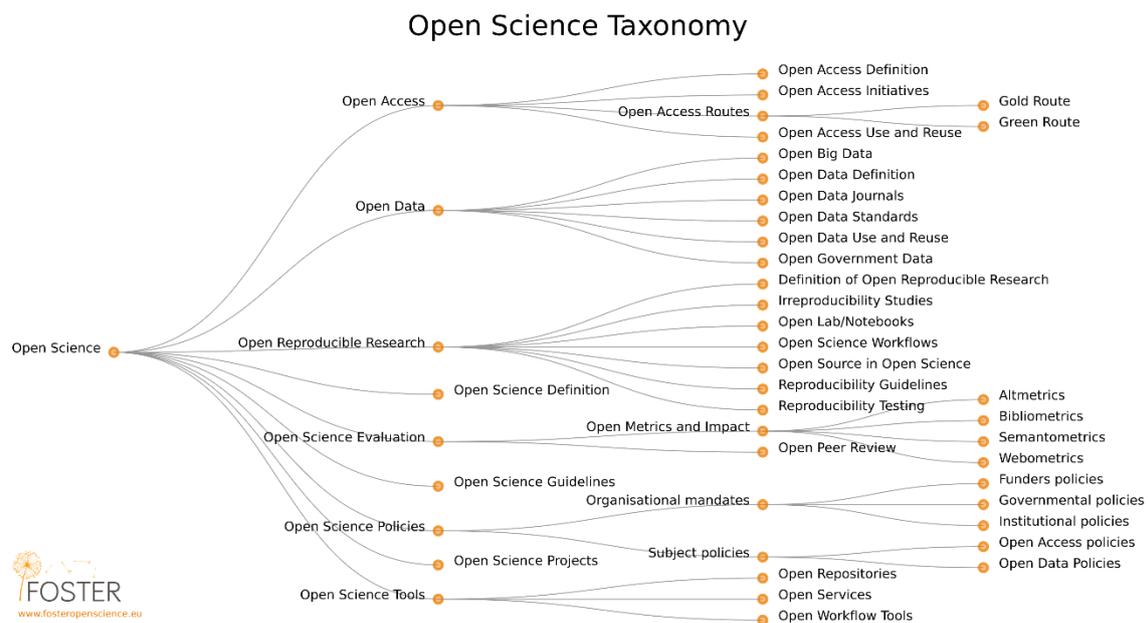
STRATEGIES

New developments in research policy do not suddenly arrive out of thin air. They are the result of conscious effort on behalf of strategic actors with specific goals in mind. These efforts do not always succeed smoothly and without interference, though. There are always counter-movements and general systemic inertia that threaten to stop, derail or change the direction of any development.

It is important to understand the drivers and barriers for developments like Open Science. What exactly makes an opening up of all aspects of the research process viable and attractive? Who is interested in making it happen? Conversely, we can ask who might try to slow down or stop the process. What are the costs of trying to overhaul the research process, both financially and from a human perspective, and are they worth it?

In the following, we describe some important factors that act as drivers and barriers for Open Science implementation in research institutions generally, before moving on to the position occupied by research libraries in the research support ecosystem and the illustrative case of Open Science policy and support infrastructure at the Norwegian University of Science and Technology (NTNU). We end with a discussion of future challenges and some reflections on the ways in which research libraries will have to change if they want to take responsibility for a part of the research process that they previously did not have.

DRIVERS OF OPEN SCIENCE

As we see it, there are three main developments from recent years that together work as drivers for Open Science. The first, digitalisation, has to do with recent advances in the technological

prerequisites for modern science. The two others are a combination of researcher-led community initiatives for research conduct more in line with scientific ideals and a top-down, policy-driven demand from funders to get more out of the extremely expensive research effort of countries and private funding organisations. These two drivers are themselves partly a response to the possibilities opened by digitalisation, but act as factors that move research in a specific direction according to the ideological and strategic positions of the people advancing them.

DIGITALISATION

A cornerstone of the shift towards Open Science is the increased utilisation of the benefits inherent in digital production and dissemination of research. Digitalisation allows for rapid collection and digestion of existing research, improved collaboration between researchers without the need for physical proximity and increased possibilities for disseminating and sharing research once it has been processed in the form of scientific publications and related research data.

Digitalisation brings challenges and opportunities in the form of a shift in the services required. New requirements for Open Science have greatly increased the need for improved research support structures at research institutions and the acquisition of new competencies in all parts of the research organisation.

In the field of information management, the effects of digitalisation have been on display for years already. Libraries and publishers have already switched to a mainly digital literature retrieval and delivery structure, a process that has greatly simplified the referencing work of researchers. It has also had the effect of shifting expenses from maintaining physical collections to buying electronic literature delivery through agents – for example, 95 % of NTNU's library budget is now connected to electronic literature resources, up from 36 % a decade ago. This has freed up human resources at libraries to expand and improve research support services within other fields. Hence, we see a convergence of effects of digitalisation on a new role for research libraries within the expanding research support infrastructure.

POLICY WORK

At the highest level the European Union, through the European Commission, influences the research landscape by different means, including legislation, policy-making and funding. The Commission has published several Recommendations and Communications focused on open science and open access. The "Commission Recommendation on Access to and Preservation of Scientific Information" from 2012 is arguably among the most important of these. It was updated in 2018 to reflect developments in policy and practice and prepare for the next Framework Programme. In addition, several other major international organisations have issued declarations, statements or guidelines on open access to research publications and data, including UNESCO, OECD and the G7/G8.

The European Commission has mandated all member states and applicants to the European research framework programme Horizon 2020 to comply with its extensive rules for Open Science. EU funded projects have for a while had to make their research publications openly available immediately or after a short embargo period and are now also required to make available the data underlying the claims made in the publications, by participation in the Open Research Data Pilot.

International policies, in particular those of the European Union, have been important for the development of national guidelines and strategies, including in the Nordic countries. In Norway, the Ministry of Education and Research in 2017 issued "National goals and guidelines for open access to research articles" as well as a "National strategy on access to and sharing of research"; with clear expectations that publicly funded research, publications and data should be open and accessible. The Norwegian Research council has since 2009 required that funded projects should make publications openly available, and in 2014, their policy on Open Access to research data was released.

The guidelines and expectations from funding agencies and the Norwegian government are strategic efforts to promote Open Science. Specific mandatory requirements as well as allocation of funding are important incentives to change practices, including raising awareness on the issue of Open Science in the research community as a whole.

COMMUNITY-LED INITIATIVES

Although policies and guidelines are important drivers, research communities have been at the actual forefront in promoting Open Science and the associated change in culture and practice. Discourse on the values and ideals of scientific practice has started among subgroups of the key actors, the researchers themselves, and has in turn shaped the policies.

Many of the ideals and values underlying Open Science are not new. As early as 1943 the so-called Mertonian norms of modern science were described; communalism, universalism, disinterestedness and organized scepticism (Merton, 1973). In particular the norm of communalism, that findings in science should be considered common goods, can be directly linked to the idea of Open Science. However, actual practices and culture have not necessarily adhered to the same ideals, with the obvious example being the system for scientific publishing. The various initiatives based in or led by research communities have been essential in shaping the Open Science agenda.

A well-known example of an initiative to give open access to scientific publications is the pre-print server arXiv.org. Here, research papers in physics were distributed freely and quickly, and arXiv has since included several other areas of science. Other aspects include large-scale international collaborations that make data publicly available, like The Human Genome project or CERN, or local initiatives to develop open resources to be used by other researchers, with an example being the Allen Brain Atlas.

BARRIERS TO OPEN SCIENCE

Of course, the Open Science field is not uniformly moving in one direction. Some developments have the potential to act as barriers through significantly slowing or reversing the shift towards more open research processes. While it is important to be aware of the factors working against this transition, many of the strategy documents that promote open science take for granted the benefits without paying enough attention to the possible downsides of making such a comprehensive change to the research process.

Policy documents are usually written with the intention of achieving a specific goal in mind, and therefore tend to stress the benefits of implementing change rather than frankly discussing the costs. However, the picture is more complex than such documents sometimes make out. One often overlooked aspect of transition processes are the transactional costs of changing modes of operation. These can take the form of actual monetary costs connected to investments in necessary infrastructure for new ways of doing and documenting research, but also in the form of institutional inertia that is present in all institutions of a certain size. In addition, while there are certainly many researchers that welcome the move towards a more transparent research process, others raise concerns over increased workload and closer monitoring in a field that is already feeling the strain of the 'metric tide' in research (Wilsdon et al. 2015).

INFRASTRUCTURAL COSTS

An increased focus on researchers' obligations to manage and make available data and publications also means a need for increased institutional support. Institutions must carry the costs of data storage, repository maintenance, researcher and project manager training, support services and dedicated work for better research project documentation and standards compliance.

Even where many of these costs can be covered by research funding through direct funding eligibility and overhead costs to the institutions, this burden must be seen in relation to the increasingly strained budgets of most modern research and higher education institutions.[1] Many institutions are not in a position to hire a large support staff specialising in every aspect of Open Science.

These financial obligations can partially be alleviated by potential gains from participating in a more open scientific process. If proponents of Open Science are correct, research institutions stand to realise large efficiency gains from identifying and reusing work done elsewhere. The prospect of improved collaboration within and across research projects also carries the promise of unlocking scientific economies of scale. However, this is far from guaranteed in the case of each individual institution, who still has to deal with the new demands.

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[1] At NTNU the budgetary share of the library has gone down from 2,5 % to 2,1 % in the last decade.

INSTITUTIONAL INERTIA

Regardless of whether the push to implement Open Science is community-led or a requirement from the topmost policy level (or both), institutional change often turns out to be slower and more difficult than the formulation of good policy or identification of best practices might lead one to believe. It is a well-known feature of large institutions that significant change is difficult to achieve without some sort of change in the underlying conditions of operation, as "institutionalised arrangements and practices structure cognitions, define interests and, in the limit, produce actors' identities" (Maguire 2007: 674). Overcoming institutional inertia in the form of fossilised structures entails the ability to reformat structural characteristics of the organisation, as well as identifying agents who can work to effect institutional change.

Identifying the institutionalised arrangements and practices is not necessarily a straightforward task. Research institutions have many goals they wish to achieve within the field of research, and often use incentives designed to encourage publications in specific publication channels and in particular forms to drive things such as funding allocations or academic career advancements. These incentives do not uniformly direct effort towards a single goal such as a more open scientific field, but rather serve many goals. Sometimes, these are in direct conflict, such as promoting both increased quantity of research publication and a larger share of highly cited publications. These things will affect how institutions delegate resources to achieve divergent goals, and can serve to dampen the effect of Open Science initiatives.

RESEARCHER HESITANCE

The fundamental idea of Open Science is to introduce mechanisms of openness, sharing and transparency to the different stages in the research process. This should help reduce the occurrence of scientific fraud and misconduct, increase societal returns from research spending and in the final instance pay dividends in the research process itself, as publications, data sets and code become openly available for all interested parties.

There are, however, significant costs connected to this, which much be borne by the individual researcher or project in the form of work to describe, curate and deposit publications or data sets in requisite repositories. An additional challenge is the effort needed to change existing practices and to develop the necessary skills and competency on top of the skills required to actually carry out the research in question. These personal costs have a tendency to accumulate.

Attitudes towards this extra work and intrusion into existing practices vary considerably between researchers. Where some welcome the prospect of increased sharing and openness, and are willing to adapt to a new way of working and invest that extra effort in learning new standards and new requirements for documentation, others feel the baseline workload of research and academic administration are high enough that additional requirements will lead to undue demands on researchers and project leaders.

In addition to attitudes, researchers are as mentioned above already embedded in incentive structures that reward other kinds of research behaviour, such as publishing in high-ranking journals or keeping research findings under lock until their conceivable value for the original authors has been exhaustively exploited. As one survey of researcher attitudes towards Open Science points out,

> "The incentive system in place is shown to be firmly linked to the traditional process of knowledge creation and dissemination based on peer-reviewed publications in high-ranking journals. […] the researcher is constrained between their organisation's 'visions' and 'mission statements' which encourage collaborations and openness and the incentive to exert caution in disclosing research findings until these are certified by a certain type of publication." (Gagliardi et al. 2015: 127)

OVERCOMING BARRIERS

Identifying these three barriers and developing alleviating measures to counter them are crucial to succeed in Open Science promotion. In the case of issues of institutional preparedness and infrastructural deficits this can be solved by better resource allocation or changes to institutional incentive schemes. However, in the case of potential researcher hesitance only close cooperation with the affected parties on exactly how Open Science can be realised in accordance with the goals

of good scientific conduct and without encroaching on academic freedom will be helpful in lowering barriers.

Without proper alleviating measures, the barriers to Open Science could potentially be large enough to stop it from ever bearing fruit. However, we believe the drivers for Open Science are both stronger and with a clearer converging tendency than the barrier. After all, as Gagliardi et al. note, "in many circumstances research professionals and their employers have aligned interests in open science" (2015: 126). While the whole, comprehensive programme of Open Science might not be realised shortly (or even ever, in some of the more utopian versions), institutions and researchers would do well to treat the movement as a real factor that will influence how research is done for decades to come.

UNIVERSITY LIBRARIES AS CHANGE AGENTS

The drivers and barriers described above are of a general nature, and apply to the whole of research institutions. Open Science touches upon central functions of all parts of research, including IT infrastructure, legal and managerial support services. Because of this, any one of these units could in theory be the hub of a research institution's Open Science efforts. There are, however, good reasons to point to university libraries as particularly well-suited to take on a central role in supporting Open Science and realising institutional goals of more openness and transparency in the research process. These have to do with both the existing core competencies of modern research libraries, and their particular intermediary position within the research institution.

CORE COMPETENCIES

Digitalisation has helped change the role of the libraries from being collection holders to service providers. An increasing portion of the literature and resources traditionally provided by the libraries are now digital, and the libraries actively curate, preserve and disseminate this research output. Unlike many other digitalisation processes in research institutions this digitalisation has already taken place in the library sector. As such, going digital is already part of the core competency of a modern research library.

Similarly, the challenges of standardisation and proper metadata management in Open Science play into a different core competency of libraries. Many of the standards of information science and data management have their roots in library science, and core elements of metadata handling in data repositories, citation networks and publishing platforms all come from work done in connection with library collections.

Libraries are also often responsible for other systems in connection to research and publishing. Institutional repositories, publication funds, small presses, research data and learning object repositories are all separate systems that rely on particular ecosystems of software, standards, procedures and metadata descriptions. All of these are typically handled by libraries, and together the form the core of what is usually taken to be under the purview of Open Science. While each individual element could conceivably be handled somewhere else, for example in an institutional IT department, or by a dedicated publishing environment, it is difficult to envision a single milieu that could host the comprehensive package like research libraries.

INTERMEDIARY ROLE

In addition to having existing competencies within the library that align well with the challenges of Open Science, the library occupies a particular space in the research institution organisation. Libraries do not occupy a particular place somewhere in the middle of the typical research institution hierarchy which goes from individual departments organised in schools or faculties which are then governed by a central administration. Instead, libraries often operate with a duplicate shadow structure of their host institution, with local branches specialising in serving the needs of the particular subjects of their local research groups. While this means that libraries run the risk of organisational separation from their institutions, it also means they are in a position to act as important and frequently "neutral" intermediaries between science policy and the research community.

Keller (2015) highlights the importance of liaison librarians in supporting research and acting as brokers between general policy recommendations and the specifics of particular research subjects. Particularly, success has been found in the creation of subject-specific support teams within libraries

that can include Open Science commitments in their support portfolios. Research librarians already have to be familiar with the strategic priorities of their local scientific groups, and are frequently involved in very hands-on support tasks in developing research projects or setting up targeted research queries.

THE NTNU CASE

So far, this discussion has been conceptual. Here, we would like to expand it by showing how the above considerations feed into an actual institutional process by describing how first open access and later Open Science was taken into institutional policy and assigned organizational resources according to responsibility at the Norwegian University of Science and Technology. As a large research institution, with more than 4400 research full time equivalents and more than 40 000 students, NTNU already features a sizeable support infrastructure for many research activities. This includes teams for aiding research project proposals, international collaboration, research dissemination and researcher recruitment efforts.

As described above, an institution that wants to make progress on Open Science needs to meet institutional inertia with strong policy support, increased infrastructural burdens with robust investments into support mechanisms and possible researcher scepticism with solid professional anchoring. This section details how NTNU, and especially its library, has tried to do this, and ends with a discussion of the challenges and possible pitfalls still ahead.

FROM OPEN ACCESS TO OPEN SCIENCE

The first formulation of what would end up as a general policy support for Open Science can be traced back to the adoption of a new general publication strategy at NTNU in 2014[2], which states as a general principle that "Knowledge should be easily accessible for those who wish to use it […] Open Access contributes to the sharing of knowledge regardless of economic concerns" (our translation). In this strategy it is a clear objective that academic publications at NTNU should as a rule be published through Open Access channels. The strategy was followed up with an Action Plan for Open Access 2016-2020, with concrete, measurable and ambitious aims.

Included in this Action Plan for Open Access is the aim to consider the development of integrated services within the overarching theme of Open Science. This includes Open Access and Open Data, and the goal is to provide support throughout the whole research process from planning to final publication. It also includes provisions for further developments with Open Science at a later date, such as open peer review or formal open software requirements. As a continuation and further development of this, a separate Policy and Action Plan for Open Access to Research Data was approved at NTNU in January of 2018. The main principle in this policy is that research data at NTNU should be as open as possible. Included in the policy is a description of the roles and responsibilities of the researchers and faculties at NTNU, as well as NTNU centrally.

In the action plans, for both Open Access and Open Access to Research Data, the NTNU University Library is given the main coordinating responsibility for implementation of the policies related to Open Science, in collaboration with the IT and Communication divisions and the faculties. This is the result of the library taking an active role early in the process and working in close collaboration with the research administration in the formulation of the policies for Open Access and Open Data.

This was possible because the library had been working on strengthening its competencies and available resources for Open Science for some years. It did this through targeted hiring for positions working specifically with open access to publications, open bibliometrics, and open research data. Also, an internal training process to raise the competency of the liaison librarians on these topics has been established. This competency building bore fruit when it came time to assign responsibility for carrying out the policies of the administration.

SUPPORT STRUCTURE

While the formulation of concrete principles for Open Science only took shape in 2014-2015, the actual infrastructure to support this had already been in place for more than a decade before that. NTNU's institutional repository for research publications, NTNU Open, has existed for more than a

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[2] The publication policy can be found at https://www.ntnu.no/publiseringspolitikk.

decade. A publication fund for covering article processing charges in open access journals has also been established, and the fund has expanded from meagre beginnings to covering costs of around two million NOK (around € 200 000) annually. NTNU also hosts an open access publication platform with 11 currently published journals.

In terms of more recent developments, the need for NTNU to develop a better infrastructure for IT services for research collaboration has necessitated increased collaboration between the library and the IT department on questions of research data. In 2017, the two departments collaborated on a joint survey of researcher knowledge about and attitudes towards open research data and publications, which has later manifested in a more formalised collaboration

LISTENING POSTS

It is crucial that the library manages to fulfil its intermediary role to a satisfactory degree. Understanding the needs of the research community while working to promote mandated policy is not just a delicate balancing act but requires well-organised strategic work on behalf of the library. With that in mind, the university library of NTNU has taken steps to become a form of listening post for both the research administration, who care about the general development of the institution itself, and the research community, who often have issues specific to that particular subject that they might need assistance with.

The most important of these is the assignment of both an external and an internal Open Science group based in the library. The external group has members from each faculty of the university, some of whom are research administrators and some who are active researchers. This group acts as listening post for the library, helping identify where there are issues in the research communities that must be taken into account when advancing with Open Science policies.

In concurrence with the external group, the library has an internal Open Science team, responsible for developing training material for the organisation so that the library has a competent first line of service on Open Science in addition to the positions that are dedicated to this work. This increases both the competency of the whole library and the value to faculty in having a library that can meet their needs quickly and competently.

A third anchoring activity is the existence of a permanent "department tour" on Open Science issues, where the library's Open Science team frequently visits faculty around the university, talking about existing and new policies and how these impact the concrete work of research and trying to understand how the library can negotiate subject-specific needs in relation to general guidelines.

CHALLENGES

On most accounts, the university library of NTNU seems to have done what is required to ensure that a transition to Open Science will not founder immediately. However, there is no guarantee of success. There are at least three major challenges to Open Science in the immediate future, which will have to be carefully navigated in the upcoming years for this to bear fruit.

Firstly, the push to Open Science is very much a recent development. Not only has the infrastructure and international landscape for Open Science not finally materialised, but big questions regarding the financing of the international publication system and ownership and licensing of research data are still unsolved. Until the picture on how an Open Science system will actually look is clearer it is hard to know exactly how the endgame will look.

Secondly, a single library or institution cannot affect this type of large-scale transformation by itself. It relies on stringent national guidelines and policies, and most probably a more unified system of incentivising researcher activities. Thirdly, Open Science is wholly reliant on researcher cooperation. While there are many enthusiastic researchers and Open Science ambassadors out there, there is also a widespread and, in many cases, justified hesitance to make large adjustments to the research process when the outcome is still unclear.

These are exciting times for Open Science. It remains to be seen how it will look in a few years, but there is a clear space for research libraries to take an active strategic role in this development. It only requires the will to think concretely about what it takes to actually move to a more open scientific world.

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