Future of Scholarly Publishing and Scholarly Communication

Report of the Expert Group to the European Commission

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PREFACE BY JEAN-CLAUDE GUÉDON, CHAIR OF THE EXPERT GROUP

The following pages are a testimony to a collective voice. All members of the expert group on the future of scholarly publishing and scholarly communication were involved actively at every stage of the work. They chose to engage very generously with their time, and, in doing so, they revealed the formidable reach of their expertise. Thank you, each one of you, for your efforts.

The European Commission personnel must also be thanked. Jean-Claude Burgelman has constantly supported the expert group. My personal thanks go to him. The role of Victoria Tsoukala, always central, became critical after September 2018 as the preparation of the report entered its final phase. She extended her efforts beyond measure. She constantly made sure that the the expert group was moving along well, and that the Chair was not forgetting a "detail" or two, otherwise known as crucial elements. Thank you, Victoria! Until September 2018, Jean-François Dechamp also played a very important role beside Victoria Tsoukala, and he too must be thanked.

The collective voice of the report is a complex one, and although complete agreement was not always possible, a shared vision of direction of travel was achieved. Involved in what is generally known as "future studies", the expert group gradually found itself involved with a subcategory of this field, known in Europe as "foresight". Foresight corresponds to a form of future studies that privileges critical thinking applied to shaping the future through influencing public policy. In this particular case, this meant identifying the key actors, establishing the nature of their status and roles, identifying their inter-relationships, understanding the nature of the tensions between them, and understanding also where room for collaboration and synergies existed. In the face of an extremely mobile communication and publishing landscape, it was also important to identify elements of permanence, continuity and stability. In effect, by identifying functions and principles, the expert group was setting its sights on fundamental bearings. It could then adumbrate what new social, institutional, technological and economic configurations could come together to form a desirable future for scholarly publishing and communication.

The report has achieved these objectives. Functions and principles offer the needed guidance in a highly fluid context, and they also provide a clear foundation to describe what is not working well in the scholarly publishing world. The report then examines each of the actors with a view to determining their specific degrees of freedom.

The conclusion is actually simple: the evaluation of research is the keystone, and it has already been identified by scholars around the world, and by various expert groups within the European Commission, as structuring a global research architecture characterised by an unlimited quest for rankings. The ranking imperative affects all levels of the research structure, and it tends to constrain change for nearly all actors. This is true of individual researchers, of research groups, of whole research institutions, and even of whole countries. Symmetrically, publishers design their marketing strategies around journal rankings. But they too have become prisoners of this strategy, even though they benefit from it, and they have difficulties seeing beyond it.

Funding agencies also use rankings, sometimes abundantly. However, unlike the other actors, private funding charities are not ranked, and public, national, funders are ranked only indirectly, through their own country. As a result, funders in general enjoy more latitude than the other actors in scholarly communication and publishing. The European

Commission, as a public funder, also operates transnationally, and this special status tends to shield it from the ranking anxieties that may affect national funders.

The report concludes with the general thesis that the scholarly publishing landscape can be meaningfully changed only if the funding agencies take the lead and initiate change. But, to achieve this goal, they will need to work in close association with researchers, research institutions and learned societies which, for their part, will need to increase their responsibilities in this regard. The age of outsourcing-by-default - or is it punting? - may be at an end, and, if so, it should be replaced by strong networking efforts among these actors. Funding agencies will also need to provide more of an effective voice to the general public and its various constituents. They can also work with publishers who are willing to support the development of a scholarly publishing and communication system that corrects the flaws presently observed. For their part, publishers can meaningfully cooperate with other actors, but only if they adapt their business models to an evaluation framework where intellectual and economic value are not entangled as they presently are.

Funding agencies, with their access to money and their relative freedom to act, are probably best suited to shape and develop the scholarly publishing landscape of the near future, and their growing collective commitments to open science are positive signals in this regard.

Finally, attentive readers will note that a number of common words such as stakeholders or sustainability are largely absent from the text. The reason is that such labels simply paper over real problems without addressing them. Their value is diplomatic rather than analytical. For example, it is clear that the sustainability of a large commercial publisher, of a small society publisher, of a library, or of a research institutions each rests on very different parameters, and corresponds to very different objectives. Likewise, the word "stakeholder" originally emerged within commercial companies facing deep internal divisions: it refers to conflicts that cannot be explicitly mentioned. In short, they work against being truly informative. Resisting these terms also helps against recycling familiar tropes too easily. Thinking, true thinking, can be foregrounded in this manner. Readers will decide if the foregrounding actually took place.

Jean-Claude Guédon, Chair

Expert Group on the Future of Scholarly Publishing
and Scholarly Communication

EXECUTIVE SUMMARY

The Expert Group on the Future of Scholarly Publishing and Scholarly Communication was set up to support the policy development of the European Commission on Open Science. The Expert Group was asked to assess the current situation with regard to scholarly communication and publishing and to establish general principles for the future.

This report analyses the recent past and present states of scholarly communication and publishing. It proposes ten principles through which a vision for scholarly communication is shaped over the next 10-15 years. These principles also serve as a way to examine shortcomings of the current scholarly communication and publishing system. The report then offers recommendations to key actors in the scholarly communication system about the best ways to address these shortcomings. The discussion in the report focuses mainly on journals and articles, although books and monographs are also considered, as well as the significance of new and emerging forms of scholarly communication.

The perspective for improvements is researcher-centric, with research contributions considered as a public good. Locating research within society at large, and taking into account the needs and possibilities of those who are not professional researchers – the majority of people – is another fundamental reference point for this report. H. G. Wells' image of the world brain provides a useful metaphor to sketch the shape of the desired outcome.

Scholarly publishing (and, in particular scientific publishing) has deeply changed since the Second World War. With few exceptions, society and association-based publishing have declined in importance, while commercial publishing has become dominant. Then, in the 1970s, the "Science Citation Index", a bibliographic tool based on citations and designed by Eugene Garfield has led to the development of a journal metric called the Journal Impact Factor (JIF). This metric has contributed to re-organizing the competition among scholarly journals, and has led to a mode of research evaluation based on which journal researchers manage to publish. Finally, the prices of scholarly literature began to rise well beyond the inflation rates observed since the 1980s, and the growth of the scholarly literature, while significant, does not entirely account for a trend that has increasingly burdened universities and research centres.

Digitisation (online publishing) also began to transform scholarly publishing in the mid-1990s. Its main consequence was to shift the commercial transactions from buying copies of the literature to negotiating rights of access (licensing). It also led to the practise of bundling journals into "Big Deals", where libraries buy access to entire collections of journals from publishers. This business model deeply affects the market structure of journals. A system of sharing research outputs has been established across the planet, but it does not reach everyone in an equitable manner. Some innovative features have been added to that output, but much more could be done.

Open access is made possible by digitisation. The motives behind its emergence are linked to the desire of making the fullest use of the possibilities opened up by computers and networks. Finding a way to constrain prices was a second motive. The same innovative spirit leading to open access also led to exploring new publishing models with open access as a basis.

Key principles for scholarly communication in the 21st century, and current shortcomings

Deep changes have affected scholarly publishing, but the process itself has remained remarkably stable. It includes four key functions that have accompanied scientific publishing since the 17th century: registration (attribution), certification (peer review), dissemination (distribution, access), preservation (scholarly memory and permanent

archiving). Evaluation is another function that has been associated to scholarly publishing in the last few decades, in particular though the JIF, but its role is increasingly contested. Digital technologies do not disrupt the publishing functions, but they allow for their distribution among different actors, and not just publishers (in the traditional sense of the term).

The expert group proposed a set of principles that should characterize scholarly communication and which can help achieve an effective world brain with researchers at its centre: scholarly communication, needs accessibility, maximum usability, and accommodating an expanding range of scholarly contributions (data, software, new documentary forms, etc.). Scholarly communication, given the nature of scholarly activities, also needs to rest on a distributed infrastructure based on open standards to ensure access and interoperability. The specific values attached to scholarly communication lead to paying much attention to issues of equity, diversity and inclusivity, and to the need for community building. They also lead to a deep concern for the quality and the integrity of scholarly contributions. Finally, scholarly communication should be designed in such a way as to promote flexibility and innovations while also retaining its focus on cost effectiveness.

In its present state, the scholarly communication system displays a number of shortcomings that need to be addressed. On the open side, open access is far from its objective of reaching 100% of publications, and even when open, usage is regularly limited because the access licenses to content are either unclear or missing. On the technical side, the traditional article, often in PDF format still predominates and the interoperability of platforms remains limited by the competition-driven constraints of commercial publishing. Structural inequalities (money, resources, prestige) are also intensified by competition organized around rankings and the impact factor despite many studies showing how such a metric is both simplistic, and may even distort the research process. The building of research communities is hindered by various forms of delays (peer review, embargoes). The process of certification (peer review), while essential to scholarly communication, is increasingly criticized for biases, opacity, etc. Commercial firms also tend to treat new technologies as elements of competition, thus favouring fragmentation and tactics such as lock-in. Finally the journal market, which, in itself, is not completely aligned with the research forum of theories, concepts and facts, also lacks transparency when considered from the perspectives of production costs and price setting.

Key actors in the scholarly communication system

Complex inter-relations characterize the key actors involved in scholarly communication and publishing, while their roles are also changing, as enabled by new technologies and newly acquired aspirations.

At the centre of this ecosystem lie the **researchers**, but they themselves display contrasting forms of behaviour. On the one hand, they are information seekers; on the other, they are status seekers. They are strongly influenced by the reward system and the tools used to assess their work (in particular the impact factor). However, a system organized around the impact factor privileges competition of all against all, despite the fact that scholarship also needs collaboration. Researchers' selection of a publication channel is, on one hand, unduly influenced by a concern with rankings and, on the other hand, decoupled from the financial implications of their choice. With article processing charges, researchers are more directly involved in the financial dimensions of scholarly publishing, but this element can also translate into further forms of competitions for limited funds. Researchers, therefore, need to find ways to act more collaboratively, more collectively, and they need to assert these needs to balance competition with cooperation and collaboration. Scholarly/learned societies and other researcher communities are best positioned to affect change across all aspects of scholarly communication. Finally, an important, yet poorly studied, subset among researchers needs to be taken into account:

at the interface of the research world and the publishers, one finds the journal editors and members of editorial boards.

Universities and research centres seek to foster research and the dissemination of knowledge to the research communities and society at large as part of their missions. However, universities and research centres are financed in various ways – government or private funds - and their financial base is related to various forms of assessments and rankings. As a result, many institutions attempt to craft their incentives and assessment tools to secure better national and international rankings.

Universities and research centres collaborate as well as compete with each other. It is to the advantage of these institutions to see all their research contributions openly available, discoverable, and re-usable, and they also have the ability to change their own internal reward system and their incentives. With their libraries and university presses, universities and research centres also have the means to redefine their publishing and other roles within the scholarly communication system.

Research funders and policymakers in both the public and charitable sectors support research for public good purposes. Funding of research as a public good implies a particular concern for quality, access and effective dissemination. They are often directly involved in the evaluation of institutions, while they organize the evaluation of grant submissions. Such evaluations are usually based on a measurable performance basis, the usual result of which is to intensify competition, including in publishing. They set the quantified parameters of such evaluations. Research funders, therefore, can affect directly or indirectly all functions of scholarly communication, and have considerable power to promote change, most notably in the incentives and rewards systems of research. Funders and policymakers have already played a significant role in the expansion of open access by mandating policies, as well as supporting open science through infrastructures (repositories and public publishing infrastructure) or paying for APCs. They are also increasingly becoming involved in other aspects of scholarly communication, including publishing.

Publishers, both commercial and not-for-profit, are presently the major service providers to researchers, universities and other research institutions, as well as funders, for all the key functions of scholarly communication. They compete with each other, with competition focused mainly on the 'brands' of their journals (as expressed through strictly quantified rankings), the scope and efficiency of their services, and the effectiveness of their interactions with other actors involved in scholarly communication. Digital technologies make it possible, to disaggregate the key functions in scholarly communication and publishing. The future roles of existing actors is therefore likely to change, and what is already clear is that publishing is involving an ever greater number of players who provide services in scholarly communication, with for-profit and not-for-profit actors participating, a mix of financial resources supporting them, and new business models emerging. The continuing digital revolution presents a number of challenges (and opportunities) for publishers, not least since it increasingly calls into question what scholarly 'publishing' means. The current uncertainties in scholarly publishing lead publishers to pay great attention to what makes the present system work, in particular the underpinnings of the journal ranking system, the JIF. Publishers can work on new systems of evaluation, but they will probably design and accept them only if they link economic and intellectual value in some fashion. Publishers can also offer solutions for the improved presentation and use of research contributions in a digital context, and they can optimise publishing functions in the digital environment.

The fifth category of actors includes **practitioners, educators (and their students), and other social groups** with professional or personal interest in research (e.g. patients, civil servants, citizens involved in specific issue, etc.). This variegated group – society at large, in effect – lacks a voice to influence research orientations or priorities. Often constrained to popularisation as way to relate to knowledge, this category of actors often feels removed from research to the point of inducing feelings of scepticism. They deeply need open access, and they also need structured channels of communication, in particular

with funding agencies, policy makers, and research communities. They should have a voice in the orientation of research and its priorities. They can also participate in certain types of research projects (including, but not limited to, crowd-sourced collection of data).

Recommendations to key actors:

Researchers and research communities should:

1. When participating in research assessment*,* for example in hiring, promotion and tenure, and funding decisions, focus on the merits and impact of a researcher's work and refrain from the use of metrics - particularly journal-based metrics - as a proxy. In particular, they should incorporate the recommendations from DORA and the Leiden Manifesto into the assessment process.

2. Take responsibility for ensuring that all research contributions are made openly available, discoverable, and reusable according to agreed community standards (including the FAIR principles).

3. Increase awareness of, and sense of responsibility for, implications of choices and actions in roles as authors, reviewers and members of decision-making groups.

4. Strive for a balanced and diverse representation (in terms of gender, geography and career stage) when seeking collaborations, organizing conferences, convening committees, and assigning editors and peer-reviewers, and building communities such as learned societies.

5. Work towards increased recognition and appreciation of peer-review work as core research tasks. To this end, support greater transparency, including the publishing of signed reports. Support better training and inclusion, and focus on quality of the research in peer review[1].

6. In the case of communities of researchers, such as learned societies, develop policies and practices that support modes of scholarly communication in line with the vision outlined above. Along with universities, learned societies and other research communities need to alert and train their researchers to the importance and the responsibilities of communicating knowledge, either formally, through publishing, or through other means.

Universities and research institutions should:

1. Develop policies and practices to ensure that all research contributions are made openly available, discoverable, and reusable according to agreed community standards (including the FAIR principles).

2. Promote and implement the recommendations of DORA and the Leiden manifesto to ensure that research assessment takes into account a wide range of scholarly contributions including research articles, preprints, datasets, software, patents and materials (e.g. in hiring, tenure, and promotion decisions).

3. In deciding which infrastructures to use, support, and contribute to, choose platforms using free or open source software, offering open data via an open license, and

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[1]   Publons and F1000Research are but two examples of sites where peer reviews can be included in a researcher's curriculum vitae.

leveraging open standards where possible. Acting in this fashion will also reinforce researcher-led initiatives that aim to facilitate scholarly communication and publishing.

4. Strive for a balanced and diverse representation including, but not limited to, gender, geography and career stage) when hiring, seeking collaborations, when organizing conferences, when convening committees, and when assigning editors and peer-reviewers, and building communities such as learned societies.

5. In negotiations with service-providers refuse non-disclosure clauses and include clauses which enable cost and price control, and compliance monitoring. Strive to facilitate collective action with other institutions by e.g. sharing cost and price data through joint initiatives (e.g. OpenAPC).

Research funders and policy-makers should:

1. Develop policies - along with appropriate funding mechanisms - to ensure all research contributions arising from their funding are available to everyone, everywhere, without any barriers to access or restrictions on reuse.

2. When evaluating researchers, ensure that a wide range of contributions (scholarly publications, but also data, software, materials etc) and activities (mentoring, teaching, reviewing etc) are considered, and that processes and criteria of evaluation are both appropriate to the funder's research programme, and transparent.

3. Develop funding mechanisms to support the development of open, interconnected and distributed scholarly publication infrastructures, and for their maintenance over the long term.

4. Consider how funding policies affect diversity and inclusivity of research on a global scale. In particular, funders should work to ensure that review boards, committees, panels, etc., are diverse - in terms of gender, geography, and career stage.

5. Work with the other actors in the scholarly communications ecosystem to ensure that the total costs of enabling research to be openly available to everyone, everywhere, without barrier or restriction, be also open and transparent.

Publishers and other service providers should:

1. Develop and publicly announce transition plans to move as soon as possible to comprehensive open access.[2]

2. Develop, use, and support interoperable tools (including open source software wherever possible) and services not only to facilitate access and reuse of scholarly outputs, but also to facilitate innovative interventions of new entrants.

3. Strive for balanced diversity (including, but not limited to, gender, geography and career stage) among authors, reviewers, and editors who work with publications.

4. Foster transparency and accountability in peer review, for example by publishing peer review reports and author responses alongside the published articles.

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[2] Springer Nature and Elsevier have differing views with respect to this recommendation, a result of extensive disscusions in the expert group.

5. Make all publishing charges public (including special pricing and waivers), and provide *full* descriptions of services provided, in order to enable the development of a transparent and cost-effective marketplace designed to support the open communication and reuse of all scholarly contributions.

6. Experiment with new approaches to the evaluation and communication of research outputs, and share the outcomes so that a body of evidence can help to optimise future systems.

Practitioners, educators, and other societal groups should:

1. Organize and advocate for free access to, and right to reuse of, publicly funded research results.

2. Reach out to funders, research institutions, and policy makers in order to develop new communication channels, new forms of co-creation and co-planning of research, and new forms of funding in response to needs, concerns and issues emanating from the population at large.

3. Look for opportunities to engage with research topics / results that are of interest to societal groups and their communities.

4. Bring forward research topics/questions that are mis- or underrepresented (e.g. by contacting relevant researchers, attracting the attention of other actors in the science system, or mobilising action in organised interest groups).

Concluding remarks

The present situation reveals important flaws in the scholarly publishing system. Because the next decade or so in scholarly publishing and communication will be determined mainly by the ways in which the main actors interact with each other, looking for a technological solution to these flaws will not be enough. Two other ideas have also come to the fore: the main sources of money are in public or non-profit hands, and the key publishing functions can be readily disaggregated and re-allocated among the actors.

The most important structural element of the present research ecosystem is the evaluation system, in particular the JIF. It is a direct or indirect concern for the JIF that shapes many of the decisions taken by many of the key actors, researchers, universities and research institutions. The JIF also determines many of the strategies or tactics developed by many publishers. Getting rid of the use of the JIF would create real, if specific, challenges for each category of actors. For researchers, universities and research centres, and for funders, it would diversely affect deeply ingrained habits of evaluation rituals. The idea of dropping the JIF altogether worries many actors. Only the funders can act relatively freely from the JIF. For one thing, they are not ranked. And they control much of the money available to all phases of research. Any attempt at changing the publishing ecosystem, therefore, is difficult to imagine without a central, leading, and strategic role by the funding agencies.

In alliance with research institutions and their libraries, and researchers (in particular with the help of learned societies), funders can reform the general landscape of scholarly publishing and communication, and bring a better balance between the public and private sectors in the ecosystem of scholarly publishing. In particular, funders can ensure the presence of open infrastructures, open standards, and open access to all contributions emanating from their funding. They can choose to become involved in some or all of the publishing functions, and can do so in such a way as to ensure the presence of an optimal degree of openness to scholarly publishing.

Obviously, leadership taken by the funding agencies will need to be supported by collaborating actors. Funders control some strategic phases of research evaluation, and collaborating with the researchers, the universities and research centres should prove fairly straightforward. With publishers, it is clear that cooperation is also needed, and we encourage publishers to report the broadest range of evidence possible to contribute useful information for informed decision-making. Working with the general public in all of its forms should include imagining and creating communication channels allowing for the general population to exercise its influence on research priorities and orientations. For their part, some publishers may encounter difficulties in designing business models that do not take research evaluation into consideration, and all publishers will increasingly need to adapt to rules and mandates that exclude some business models.

INTRODUCTION

The Expert Group was established in September 2017, to support policy development in open science, with particular reference to peer-reviewed scholarly publications. The terms of reference required the Group to identify general principles for the future of scholarly communications and open access publishing; review Gold and Green open access models and their potential further development; analyse new types, venues and models for scholarly communications and their potential scalability; and make specific recommendations. We were also asked to take into consideration the effects of technological advances on scholarly communication, to assess new actors and emerging roles, existing functions and mechanisms in scholarly communication.

In early discussions with European Commission officials, the Expert Group was encouraged to take a long and a broad view of the future of scholarly communication to support the future planning of the European Commission. Thus we sought to develop a vision of how scholarly communication might evolve over the next ten-fifteen years itself articulated in ten principles. The vision is based on our best analysis of developments in the recent past, including the emergence of promising initiatives and an examination of their potential for expansion over the next few years. It also takes note of the various forces that help understand how scholarly communication and publishing have been shaped. The report then moves on to outline some key steps that might be taken to move towards that vision, including measures for the Commission and other actors. A list of recommendations and related actions accompanies the description of the key steps. Together, these recommendations form the substance of this report. The success of the recommendations will be measured in part by the extent to which, together, they respond to the issues raised in the terms of reference, to the concerns expressed by the Group, and how much interest it generates in relevant communities. Ultimately, it will be measured by its effects - or lack thereof - on policy decisions by the European Commission and other policy makers across Europe and even beyond.

Our work was set in the context of work already under way before we were established as a Group, including that relating to the European Open Science Cloud (EOSC), the work of the Open Science Policy Platform (OSPP), and a range of other Expert Groups, such as Turning FAIR data into Reality. We have also taken account of the Commission's work to develop an Open Research Publishing Platform.

The Group is made up of twelve members selected by the European Commission amongst applicants who responded to a call. The members fall into two categories: six independent experts selected to represent the public interest and six representatives of organisations with activities related to scholarly communication. Both groups of experts were selected as much as possible to reflect a balance in terms of expertise and experience, geographical diversity, age and gender. Organisations included researchers, librarians, foundation representatives, publishers, including open access publishers. Collectively, the Group has demonstrated a high level of knowledge and experience on the topics addressed in this report. Resolving differences in perspectives has also been part of the collective effort aiming at preparing this report.

The Expert Group has met face-to-face on three occasions, and has intensely collaborated through tele-conferences numerous times during its mandate. Representatives from a range of organisations active in scholarly communication were invited to present and discuss their perspectives at the second and third meetings. Members contributed substantial bodies of text and vigorously commented on successive drafts of this report. They furthered writing and editing using online collaborative tools.

The Expert Group benefited from presentations and discussions with guest experts who supplemented our own expertise in specific areas. We thus wish to thank the following colleagues: Barbara Kalumenos (Director of Public Affairs, STM Publishers), Iryna Kuchma (Open Access manager, EIFL), Pierre Mounier (Open Edition; Director for international collaboration), Kristen Ratan (Executive Director and Co-founder: Collaborative Knowledge

CHAPTER 1. SCHOLARLY COMMUNICATION AND PUBLISHING: CONTEXT FOR THE REPORT

The idea that problems of ordering knowledge are connected with questions of politics is not a very original one in the history of science.But this perspective has been largely absent from debates over the changing media landscape of science and of the future of scholarly publishing. … I think we need to stop carrying on as if problems of scholarly publishing are a matter simply of improving the means by which experts communicate with one another and in so doing reap professional rewards.
Alex Csiszar, The Scientific Journal. Authorship and Politics in the Nineteenth Century (Chicago: University of Chicago Press, 2018), p. 3.

The 'world brain', scholarly communication, and scholarly publishing

Scholarly communication exists to offer researchers the possibility of participating in a distributed system of knowledge that approximates H. G. Wells' vision of a "world brain". This section aims at sketching the transformations of scholarly communication in the last few decades to understand which forces are shaping the future. Wells was "...speaking of a process of mental organisation throughout the world" which he believed "... to be as inevitable as anything can be in human affairs. "The world", he concluded, "has to pull its mind together, and this is the beginning of its effort."[3]

Scholarly communication in the sense conveyed by the Wellsian metaphor refers to any form of exchange used by scholars and researchers to participate in the elaboration of knowledge through critical discussions and conversations with fellow humans. This encompasses all the procedures, from the purely informal conversation to the highly formalised stage of "publishing". In fact, scholarly publishing can be defined as the formalised sub-set of scholarly communication. Later in the report, the elements included in the formal process of publishing will be spelled out.

The interconnection between researchers first emerged with the creation of various face-to-face, largely oral, communities in antiquity. The preservation of these teachings and discussions (dialogues) was entrusted to manuscripts transmitted to posterity through careful copying. Later, individuals were able to connect across space with the establishment of various postal systems. With print, group- and networked-dissemination of knowledge became much easier. Wells' key insight was that the greatly-increased speed of telecommunications meant that the world was becoming a connected community. This trend, first associated with the telegraph, is moving with added force eighty years after Wells' prophecy: the Internet and mobile telephony display this global connectivity in spectacular ways.

As will be seen later, Wells' vision of a world brain that makes all the world's knowledge accessible to citizens across the globe provides a powerful image for an ideal state of scholarly communication. It also highlights the deeply connected nature of researchers: they are often described as individuals fiercely competing with each other, but limiting researchers to their competitive side is both incomplete and misleading: they also share a great deal, and collaborate, often across the whole planet. Without a proper balance

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[3] Wells, H.G. (1938). *World Brain*. London: Methuen & Co., Ltd.

between competition and cooperation, the processes accompanying the evolution of human scholarship cannot proceed in optimal fashion.

The balance between the two opposite forces of competition and cooperation is shaped in part by the ways in which researchers communicate with each other: in oral conversations around their working spaces, in the various ways used to seek information, and in the various means available to disseminate research results, scholars constantly oscillate between a strong sense of individual identity and the consciousness of belonging to a community[4]. In particular, it involves access to the research claims of their peers. Until recently, this largely meant getting into print, and reading printed materials.

Scholarly publishing, the research system, and its evolution

By the time research and scholarship professionalised in the 19th century, print provided a well-established mixture of articles and monographs, gradually accompanied by navigational tools as the size of the scholarly literature kept on growing. In the 20th century, these trends simply intensified, while journals increasingly came to supersede monographs in many disciplines[5].

The period following World War II witnessed deep changes, including an enormous growth of funding. Scholarly publishing had to adapt to a much increased demand, and many new journals were started, with overall numbers doubling every fifteen years. Societies and associations found the new landscape of scholarly publishing increasingly challenging. In the same period of the 1950s, commercial scholarly publishing managed to establish scholarly journals on a solidly profitable basis. A bit later, they were indirectly helped by the emergence of Eugene Garfield's Science Citation Index, and its associated Journal Impact Factor (JIF). The JIF ultimately came to provide the metric tool needed to structure a competitive market among journals. At a fundamental level, it was the granting of a JIF to a journal that mattered because it defined which journals could compete. In the 1980s and 1990s, a journal without a JIF increasingly faced difficulties in establishing its very legitimacy. Then the terms of the competition itself were set by the IF rankings as these were presented as correlates of quality even though the meaning of this metric has remained elusive and has been the source of long debates. Finally, the JIF also meant that research evaluation increasingly relied on where research results were published: journal titles became a short-hand for research quality, itself renamed "excellence"[6].

University rankings rely heavily on metrics associated with research funding, with articles published in prestigious journals – i.e. journals with a high impact factor - and with monographs published by prestigious publishing houses. So long as the funding of universities partially rests on rankings, the evaluation function of scholarly communications based on the JIF (and similar quantitative performance measurements) is perceived as being of critical importance for the management of the institution. In fact, the whole research ecosystem has invested these metrics with great power: overall, researchers, funders, and university assessments have come to rely too much on the evaluation function of scholarly communication as structured by the JIF.

With regard to the circulation of and access to scholarship in the print age, the subscription model has been the norm for journals and conference proceedings. However, increases in

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[4] Many historians of science would probably object to treating "community" as a trans-historical concept, but for the purpose of this background chapter, the notion of community can remain as a solid reference point. For a more critical approach, see David A. Hollinger, "Free Enterprise and Free Inquiry: The Emergence of Laissez-Faire Communitarianism in the Ideology of Science in the United States," *New Literary History*, vol. 21, No. 4 (1990), 897-919.

[5] The rise of journals and the decreasing importance of monographs did not happen naturally or easily. For some insights in this chapter of the history of science, see Alex Csiszar, "Seriality and the Search for Order: Scientific Print and Its Problems During the Late Nineteenth Century," *History of Science* 48, no. 3–4 (2010): 399–434.

[6] On the "regime of excellence", see, for example, Nick Butler and Sverre Spoelstra, "The Regime of Excellence and the Erosion of Ethos in Critical Management Studies", *British Journal of Management*, Vol. 25, 538–550 (2014) DOI:10.1111/1467-8551.12053.

the number of journals, and in the rapid rise of subscription prices meant that individual subscribers gradually dropped out; library purchasing became the dominant source of revenue for publishers. From the 1960s onwards – even as commercial publishers became increasingly dominant - libraries faced increasing financial difficulties. By the 1980s, talk of a 'serials crisis' became widespread[7].

Figure 1: A graphical timeline of key developments in scholarly publishing (credit: Jennifer Hansen)

1945 - 1970	1971 - 1995	1996 - 2004	2005 -
RAPID GROWTH	**PRINT PUBLISHING**	**DIGITAL AGE**	**OPEN ACCESS**

Post Second World War research funding dramatically increases and confirms the role of commercial publishers as powerful actors in scientific publishing. Robert Maxwell starts to build his publishing empire, which include: Pergamon Press, British Printing Corporation, Mirror Group Newspapers and Macmillan Publishers. A new market emerges as journals are competing through rankings, not the individual article. Promotion and tenure are granted based on what journal the researcher is published. **1950:** UNITED STATES NATIONAL SCIENCE FOUNDATION WAS ESTABLISHED. **1964**: JOURNAL RANKINGS AND IMPACT FACTOR (IF) METRICS INTRODUCED BY THE SCIENCE CITATION INDEX.	The cost of print journal subscriptions continues to rise year over year resulting in the Serial Pricing Crisis. Academic publishers start exploring pricing models for digital publishing. **1991**: THE UNIVERSITY LICENSING PROJECT (TULIP) IS ESTABLISHED. ELSEVIER AND NINE UNIVERSITY LIBRARIES EXPLORE DIGITAL PUBLISHING	Biomed Central explores a new pricing model, Article Process Charge (APC), which charges funders/authors to enable free access to individual articles. Libraries are no longer purchasing tangible objects (books, journal issues); they negotiate digital licenses to access online content. As a result, preservation, traditionally the province of libraries, is transferred to publishers. Publishers introduce the "Big Deal", a bundling practice which offers a discount to institutions who buys digital access to a whole set of journals. Institutional repositories, some thematic, are developed by academic libraries. **2002:** BUDAPEST OPEN ACCESS INITIATIVE RELEASES A PUBLIC STATEMENT OF OPEN ACCESS PRINCIPLES. **2001:** PUBLIC LIBRARY OF SCIENCE (PLOS), AN ADVOCACY ORGANIZATION TO PROMOTE OPEN ACCESS IS FOUNDED.	The Open Access movement continues to move forward. Publisher business models evolve to respond to demand for freely accessible research without barrier or restriction: hybrid, lay-over, new content licenses. Funder mandates emerge, requiring their funded research to be freely available. The research ecosystem moves beyond Open Access to Open Science. Four functions of publishing re-organized: registration, certification, dissemination, preservation. **2008:** UNITED STATES NATIONAL INSTITUTE OF HEALTH PUBLIC ACCESS POLICY MANDATES FUNDED RESEARCH MUST BE FREELY AVAILABLE WITHIN 12 MONTHS OF PUBLICATION. **2012:** F1000 RESEARCH, PEERJ, AND ELIFE ARE LAUNCHED. THE RESEARCHERS WORKFLOW COMES TO THE FOREFRONT AS A NEW FRAMEWORK FOR BOTH COMMERCIAL AND NON-COMMERCIAL ENTITIES.

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[7] In 1989, Marcia Tuttle launched *"ALA/RTSD Newsletter on Serials Pricing Issues"*. http://webdoc.sub.gwdg.de/edoc/aw/nspi/.

The digital environment and the evolution of open access

The development of internet technologies with the parallel quest for open access and transparency in the entire research process cycle have led to many changes and innovations in scholarly communication, both in terms of services as well as in the way knowledge is communicated. Some of the more important consequences are the following:

Renting vs owning: libraries found themselves negotiating something entirely new to them – the terms of licences to access digital journals –, rather than purchasing and owning physical copies of these journals. This new transaction framework has significantly shifted the power relation between libraries and publishers.

Bundling: publishers began to bundle digital journals into what came to be known as "Big Deals". These were attractive to the larger publishers because they tended to encompass multi-year agreements. Smaller publishers, with fewer prospects to negotiate such deals, were left with a reduced share of the libraries' acquisition budgets, and became financially more vulnerable. Publishers offering "Big deals" could also attract journals by promising a better degree of dissemination, as measured by the number of institutional subscriptions. Symmetrically, libraries initially felt that a "Big Deal" was advantageous because they gained access to a much wider range of journals, and the cost per title was going down. However, the calculus did not extend to the cost per article use or download, and, as a result, challenges to "Big Deals" have been increasing.

Portals: publishers set up portals covering their full range of journals, to enhance their visibility. Smaller publishers, and various large-scale projects – including Project MUSE, Scielo and many others – followed a similar path. Portals can help users to navigate content in new ways, with personalisation, linking and analytical tools. In so doing, they have begun to morph into platforms and stacks[8].

Digital technologies also empowered actors to take charge of various scholarly communication functions in new ways, as will be seen later. In particular, they have opened the possibility of a disaggregation of the functions of scholarly communication with the result that roles and responsibilities in scholarly communication are presently in flux.

Initially, the digital context attracted some researchers' attention, who rapidly identified solutions based on *de facto* open access. For example, in the late 1980's, Stevan Harnad began to explore new possibilities for scholarly communication, with Psycoloquy; and Paul Ginsparg's ArXiv, established in 1991, rapidly became a key vehicle for the circulation of 'pre-prints' in high-energy physics and related disciplines. By the early 2000s, with the Budapest Open Access Initiative, and the succeeding Bethesda and Berlin Declarations, the open access movement had taken form and become visible.

Around the same time (1999), innovative publishers such as Vitek Tracz were also exploring open access from a commercial perspective, establishing a set of new journals under the imprint of Biomed Central, and funded by "article processing (or publishing) charges" (APCs) levied on authors (or their proxies) instead of readers (or their proxies). This model was perceived as bringing several advantages: not only did it broaden access, but, in passing the costs of dissemination directly to researchers (or their proxies), it also offered the promise of greater transparency to the commercial transaction.

With APCs, it initially seemed plausible that a new kind of competition between journals would ensue. As it would involve researchers more directly into the economics of publishing, it was sometimes believed that it would lead to a better-functioning market, with lower prices for all. However, what was missed is that APC-financed open access

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[8] On platforms, see, for example, Rajkumar Buyya et al., "Cloud Computing and Emerging IT Platforms: Vision, Hype, and Reality for Delivering Computing as the 5th Utility," *Future Generation Computer Systems* 25, no. 6 (June 1, 2009): 599–616, https://doi.org/10.1016/j.future.2008.12.001. On stacks, the entry "Protocol stack" of Wikipedia provides a quick introduction to this notion. https://en.wikipedia.org/wiki/Protocol_stack.

journals did not compete differently from subscription-based journals. Their primary role remained that of "kingmakers" and their provision of content-based services came second[9]. The reason is that researchers, when selecting a journal where to publish, generally decide according to a number of heterogeneous criteria: the specialised editorial orientation of a journal, to be sure, but also the way their reward system works. From that perspective, they must consider whether a given journal title will effectively contribute to reinforcing their academic CV. As Aileen Fyfe puts it, academic publishing acts in three ways: "as a means of disseminating validated knowledge, as a form of symbolic capital for academic career progression, and as a profitable business enterprise"[10]. The fundamental question Fyfe and her co-authors address is how the three "tangled" imperatives affect and influence each other.

As open access grew, it evolved in two major ways:

1. Open access – a point that should never be forgotten – is a direct offshoot of the digital context: open access is difficult, if not impossible, to conceive in the absence of a marginal cost of copying and of transmission close to zero. The Internet provided the means to achieve this apparently utopian objective. The emergence of portals and, later, of mega-journals, starting with PLOS One in 2006, are other consequences of digitisation: mega-journals share characteristics with portals, where much content is brought together on a single site. The key innovation of mega-journals lies in a modified form of peer review, where reviewers and editors examine only the scholarly soundness of the submitted work, and not its potential wider interest or impact, or its fit with the orientation of the journal. As a result, in a mega-journal, content, including unusual content, can often be published more speedily, or simply be accepted for publication. Also, some mega-journals have rapidly grown to a size that would have been impossible under a subscription model, thus bringing a new kind of publication to light, with potentially disruptive consequences.

2. Open access, as part of the digital world, is gradually finding its way out of the print world and its familiar business models. It is shaping new business models where paying for access to content is replaced by publishing in open access. The need for a transitional phase became particularly visible with the so-called hybrid journals: some articles in paywalled journals are made open access on payment of an APC, while the remaining contents remain subject to subscription. Publishers saw this as a way to address a rising demand for open access publishing, while minimizing risk, and optimizing revenues.

Some open access advocates saw hybrid journals as a phase toward full open access. The number of hybrid journals has risen fast, from both commercial and not-for-profit publishers; and they have proved popular with authors with access to APC funds as it allows them to publish in JIF top-rated journals. The result, however, is that total costs have risen for libraries, their host institutions, and for funders, since APCs are added to subscriptions. A study led by Jisc in the UK led to this conclusion, among others:

The APC market is part of a broader landscape of the total cost of journals. As such, the two should be considered together. While library budgets are declining with respect to inflation, APC and subscription expenditure is growing quickly. APCs currently make up at least 12% of institutions' journal spend and are likely to grow. This partly because the

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[9] The image is taken from the title of John J. Regazzi's book, *Scholarly Communications: A History from Content as King to Content as Kingmaker*, Rowman & Littlefield: Lanham, Md, 2015.
[10] Fyfe, Aileen, Coate, Kelly, Curry, Stephen, Lawson, Stuart, Moxham, Noah, & Røstvik, Camilla Mørk (2017): Untangling Academic Publishing: A History of the Relationship between Commercial Interests, Academic Prestige and the Circulation of Research, Zenodo: https://zenodo.org/record/546100#.WhSeiWMW38t.

number of APCs paid is rising yearly, and partly because the average APC is outpacing inflation.[11]

Responding to this situation, some publishers have accepted to seek arrangements with institutions and funders to meet the costs of APCs and of subscriptions in a single payment – the so-called read-and-publish agreements (RAP). But negotiations between publishers and library consortia have proved contentious, and some have even ended in failure.

Alongside the commercial and APC-based business models for open access publishing should be mentioned a long list of not-for profit initiatives at the institutional, national or discipline level for the publication of articles or books. Non-APC open access publishers, e.g. the Open Library of Humanities (OLH), or OpenEdition, have been especially prominent in the Social Sciences and the Humanities publishing, which have traditionally remained at a greater distance from commercial interests. Such initiatives do not levy article- or book-publishing charges, and instead rely on other sources of funding, including in-kind support, as part of their business models. National funding, grants, membership fees, and so on, contribute to this particular publishing sphere.

The complexity of the money flows to pay for two parallel systems (subscription and open access), as well as the size of the entire system is eloquently illustrated in the following diagram which features the situation in the UK [12].
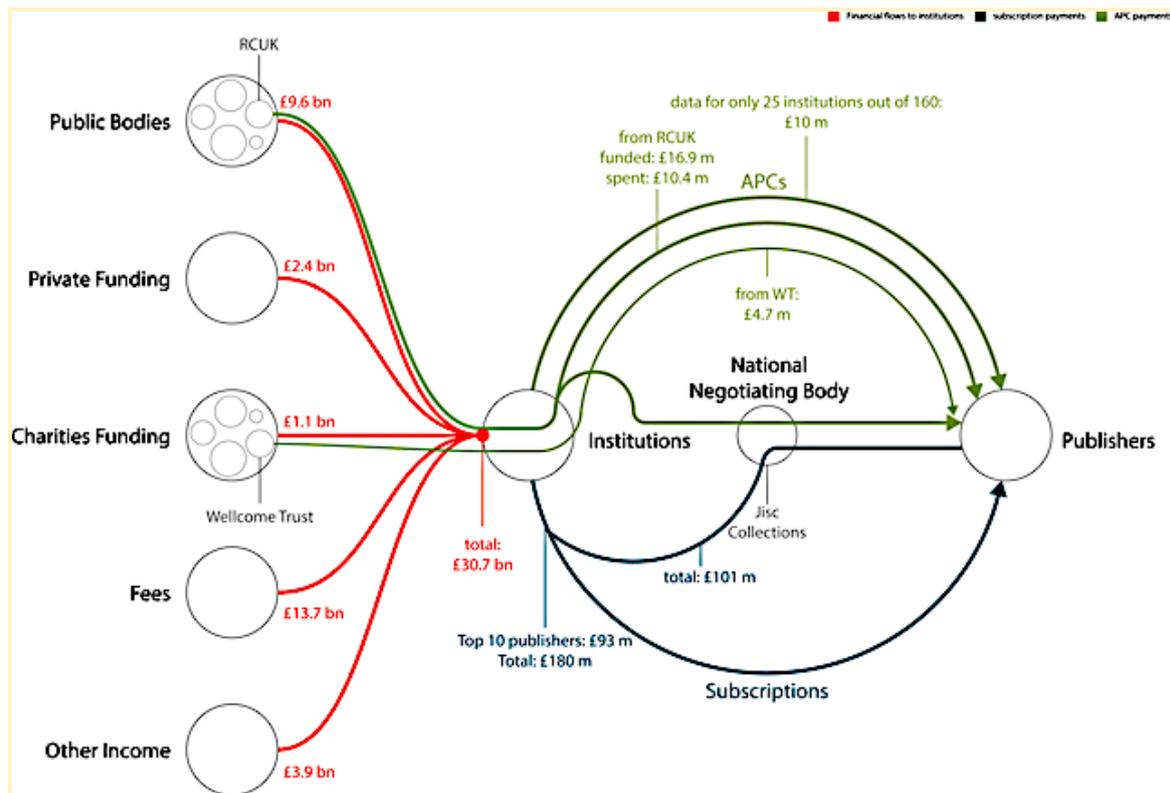

Figure 2: A graphical depiction of finanancial flows in scholarly publishing in the UK (credit: footnote 12)

Some funders and some open access advocates believe that there should be a rapid transition from the system of paying for access to content to paying for open access publishing. For example, the initiative OA2020 in Germany offers the claim that there is

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[11] Katie Shamash, "Article Processing Charges (APCs) and Subscriptions. Monitoring Open Access Costs" June 27th, 2016. https://www.jisc.ac.uk/reports/apcs-and-subscriptions.
[12] Lawson, Stuart, J. Gray, and M. Mauri. "Opening the Black Box of Scholarly Communication Funding: A Public Data Infrastructure for Financial Flows in Academic Publishing." *Open Library of Humanities* 2, no. 1 (April 11, 2016). https://doi.org/10.16995/olh.72.

enough money in the system to flip from subscription to open access.[13] The initiative, launched by the Max Planck Digital Library, is exploring the possibility of a wholesale flipping of journals, often presented as a means of accelerating the transition to open access. However, a wholesale flipping of journals to open access can be assimilated to a new form of "Big Deal"; furthermore, it does not address deeper, underlying, problems such as the conflating of prestige rankings with economic value and research quality. It also maintains journal titles (or "brands") as a flawed proxy for research evaluation.

Most prominently, the desire to move from a system that pays for access to content to a system that pays for publishing in open access has been recently and forcefully expressed by a group of funders and other organisations who published Plan S in September 2018 (cOAlition S). The cOAlition offers ten principles designed to reach the following objective: "By 2020 scientific publications that result from research funded by public grants provided by participating national and European research councils and funding bodies, must be published in compliant Open Access Journals or on compliant Open Access Platforms." In essence, Plan S envisions a future where all publication venues operate under a fully open access model. As such, it appears designed to disrupt the business models of much of present scholarly publishing, particularly the subscription and the hybrid models.[14] For now, Plan S and its supporters consider the hybrid model of journal publishing acceptable only to the extent that it is conceived as a transformative transition to open access within a three-year time limit[15].

Governments, funding agencies and open science

Governments, funders and research institutions, as well as researchers themselves, have responded to, and influenced developments in open access in a variety of ways. Many policy makers feel that open access has not made the progress that had been anticipated more than a decade ago, and this has generated a growing impatience; many also feel that the costs are too high, and that the situation must fundamentally change. Policies are, therefore, being reviewed, and institutions, as well as entire countries, increasingly understand better what is needed to effect change in what has become a global system. Plan S, mentioned above, readily fits this pattern.

Funders and policy-makers have also become increasingly interested in the much wider set of issues relating to open science and access to the vast quantities of data that underlie the findings published in journal articles and other formal kinds of publication. A significant discussion has revolved around the possibilities of research data to enhance research efficiency, innovation and the economy. The European Commission, recognizing the value of exploiting research data has set up the European Open Science Cloud (EOSC), that should become a seamless environment for all European researchers to access, process and share their data.

Besides research data, other types of research outputs are becoming increasingly valued in an open digital scholarly communication environment, including for example software and research protocols. They provide the basis for new ways of communicating research and they broaden the scope of the 'legitimate' scholarly outputs with new formats of publication, such as for example data papers and blog posts, among others. They contribute to a shift in the boundaries between scholarly communication in general and scholarly publishing in particular. Policies, along with the infrastructure and services needed to support these new areas of scholarly communication are still being developed,

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[13] "Expression of Interest in the Large-Scale Implementation of Open Access to Scholarly Journals", https://oa2020.org/mission.

[14] This is most clearly seen in the following statement from the website of cOAlition S: 'there is no longer any justification for this state of affairs to prevail and the subscription-based model of scientific publishing, including its so-called 'hybrid' variants, should therefore be terminated. In the 21st century, science publishers should provide a service to help researchers disseminate their results. They may be paid fair value for the services they are providing, but no science should be locked behind paywalls!'. https://www.coalition-s.org/why-plan-s/

[15] https://www.coalition-s.org/feedback/.

and they will clearly take some time to implement; but they will have a major impact on the whole scholarly communication landscape.

Although the amounts of money spent on scholarly communication are modest when compared with the overall costs of research, they are neither negligible nor indefinitely extensible. According to the 2015 UNESCO Science Report: towards 2030, "global gross expenditure on research and development (GERD) totalled 1.48 trillion PPP (purchasing power parity) dollars in 2013." Much of that expenditure relates to the kinds of development activity undertaken and financed by business; but of those totals, between a quarter and a third is financed by Governments, and around a fifth (23% in the EU in 2016) is undertaken by universities[16]. The costs associated with scholarly communication are difficult to estimate. The annual revenues generated from English-language STM journal publishing across the globe were estimated at about $10 billion in 2017 with a global market estimated at $25.7 billion[17], a relatively small proportion when compared with total R&D expenditure.

With regard to the costs associated with subscriptions and APCs, universities and funders (who meet the bulk of those costs) are clearly facing issues of affordability: subscription price increases have led to journal cancellations becoming increasingly common[18]. As seen earlier, the financial difficulties of the libraries have grown with the rise of APC-Gold OA and hybrid journals funded by APCs: they represent an additional set of costs for libraries. In most universities, library budgets needed to meet the new costs associated with APCs have not been increased. The adjustment of funding flows necessary to support a transition to open access is complex and far from complete. What constitutes sustainability to a business model translates into an issue of affordability for the research institutions, and this has consequences for the state of research in general.

So far, the transition to open access is achieved only in part at a global level, but it is sufficiently developed to reveal striking differences between, for example, the UK and Latin America. In the latter situation, in contrast to the the UK, national funding agencies are largely footing the bill of the publishing infrastructure, APCs are rarely used, and the costs per article are comparatively low[19]. On the other hand, the current combination of APC-based open access and licensed subscription journals in the UK has translated into higher costs for libraries and funders. Different levels and sources of funding form the backdrop of an uneven landscape where striking inequalities already exist and may even increase. In Europe, this means paying attention to the inequalities between various groups of countries within the European Union.

Conclusion

In conclusion, it is possible to state that there are now three main publishing and business models for scholarly publications.

1. **Subscriptions, the predominant model.** Most subscriptions take the form of 'Big Deals' where institutions – generally libraries – pay subscriptions on behalf of their

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[16] OECD (2017) *Main Science and Technology Indicators*, Volume 2017 Issue 2 http://dx.doi.org/10.1787/msti-v2017-2-en

[17] Johnson, R., Watkinson, A. & Mabe, M. (2018) *The STM Report: An overview of scientific and scholarly journal publishing,* International STM Association, p. 5. https://www.stm-assoc.org/2018_10_04_STM_Report_2018.pdf. The same figure is found in 2015 edition: Warte, M & Mabe, M.,*The STM Report: An overview of scientific and scholarly journal publishing,* International STM Association, p. 6 http://www.stm-assoc.org/2015_02_20_STM_Report_2015.pdf.

[18] Anderson, R, (2017) 'When the Wolf Finally Arrives: Big Deal Cancellations in North American Libraries 'Scholarly Kitchen blog, 1 May 2017. https://scholarlykitchen.sspnet.org/2017/05/01/wolf-finally-arrives-big-deal-cancelations-north-american-libraries/

[19] Abel L. Packer, "The SciELO Open Access: A Gold Way from the South", *Canadian Journal of Higher Education/Revue canadienne d'enseignement supérieur*, Vol. 39, No. 3, 2009, 111-126. Packer cites a cost of $200 to $600 per article.

staff and students to publishers to provide access to the needed literature. As noted above, subscription prices have risen very significantly in real terms in the last few decades.

2. **Open access publishing model** (for journals and monographs). Publishers make their content freely and immediately accessible with clear usage terms. They fall into two sub-categories: First, publishers levy charges (APCs for articles, BPCs for books) when the content is accepted for publication. Authors or their proxies meet these charges from a range of sources. Second, publishers meet the costs of publishing a journal or book without levying APCs or BPCs, but rather from a range of sources.

3. **Mixed publishing model (subscription and open access).** Publishers who practice the subscription model offer open access with a varying degree of timeliness (ranging from immediate to a delay of many years). Immediate open access in an otherwise subscription venue requires the payment of APCs, in what is known as a 'hybrid' model (or hybrid journals). These APCs generally tend to be higher than APCs for fully open access journals. The so-called delayed open access journals make all their content accessible on the publisher's platform at a defined time after publication, ranging from less than a year to several years. Both hybrid and delayed open access journals were designed to mitigate the perceived business risks associated with full open access, and both work by limiting the dissemination of scholarly publishing.[20]

Licensing arrangements add complexity to this simple typology; content that is free/gratis to read may not be free to use.

Recent developments include:

*   A growing array of 'overlay journals' that select and publish content that is already available freely online. They point to a possible convergence between the Green and the Gold roads to open access[21].

*   Transformations in the peer review process, including introducing the reviews into the scholarly record.

*   Transformations of the notion of a "version of record" into a well-defined "record of versions" that reflect the various evaluations, reviews and comments accompanying more flexible forms of publication made possible by digitisation.

*   Transformation of publishing into various sets of services that try to respond to the workflow of researchers, from the laboratory notes to the replication of results.

Digital advances coupled with a quest for openness and transparency in the research process have empowered actors situated across the full arc of scholarly communication and publishing to lead innovation and change. Universities, as will be seen later, are discovering that they are in a position to perform all of the functions of scholarly communication by themselves. In fact, they are increasingly taking a leading role in developing institutional publishing initiatives. Similarly, scholars are becoming publishers, sometimes innovating in collaborative ventures such as the <u>Open Library of the Humanities</u>. Funders are also becoming directly involved in the publishing process by

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[20] Schonfelder, N. (2018). Mirroring the impact factor or legacy of the subscription-based model?, <u>https://pub.uni-bielefeld.de/record/2931061</u>; Stephen Pinfield, Jennifer Salter, and Peter A. Bath, "A 'Gold-Centric' Implementation of Open Access: Hybrid Journals, the 'Total Cost of Publication,'; Policy Development in the UK and Beyond," Journal of the Association for Information Science and Technology 68, no. 9 (September 2017): 2248–63, <u>https://doi.org/10.1002/asi.23742</u>.
[21] Strictly speaking, Green refers to peer-reviewed articles and, presently, peer-review is provided by existing journals. Overlay journals, however, offer peer review on top of open repositories. See, for example, *Discrete Analysis Journal*, <u>https://discreteanalysisjournal.com/</u>, or *Épijournal de géométrie algébrique*, <u>https://epiga.episciences.org/</u>. The former is built on top of ArXiv; the latter on top of the Épiscience platform designed to publish articles submitted from an open repository.

supporting open access publishing initiatives including their own platforms such as Wellcome Open Research and Gates Open Research, or the Open Research Europe platform in the case of the European Commission. Funders also work together to create joint publishing ventures such as eLife.

Finally, cutting-edge concepts coming from researchers involve a full disaggregation and restructuring of the functions of scholarly communication, that can be controlled by researchers themselves in a perspective that takes full advantage of the digital affordances[22].

Publishing business models and funding programmes have become much more diverse and complex in the last twenty years. They each reflect a particular interpretation of the power relations, opportunities, and understanding of the affordances of the new technologies among the main actors involved in scholarly publishing and communication. The evolution of open access and open science is tied to the ways in which these actors will cooperate with each other, or struggle against each other, and for this reason, their futures remain unclear. However, one point is certain: the issue will not go away. The status (credibility, integrity, etc.) and position (elitism vs citizen science, choice of problems, etc.) of knowledge in our societies depend on the ways in which open access and open science will ultimately be shaped and stabilized.

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[22] Herbert Van de Sompel's Peter's Memorial Lecture in December 2017 deals with such questions. Access to it can be found in Björn Brembs' blog (January 16, 2018), titled "Why Academic Journals Need to Go". See http://bjoern.brembs.net/2018/01/why-academic-journals-need-to-go/. The cartoon about square wheels (by Björn Brembs) also appears in this blog (under a Creative Commons Attribution 3.0 Unported License).

CHAPTER 2. SCHOLARLY COMMUNICATION: CORE FUNCTIONS AND KEY PRINCIPLES FOR THE 21ST CENTURY

Key functions of Scholarly Communication

Scholarly communication is best described by a set of core functions that were identified when the longest-standing scholarly journal, the *Philosophical Transactions of the Royal Society of London*, was being established in 1665. As Robert Merton[23] noted three hundred years later, Henry Oldenburg and Robert Boyle identified four key functions needed by scholarly publishing:

- *registration*, to establish that work had been undertaken by individuals or groups of researchers at a particular time, and thus their claim to precedence;

- *certification*, to establish the validity of the findings;

- *dissemination*, to make scholarly works and their findings accessible and visible;

- *preservation*, to ensure that the 'records of science' are preserved, and remain accessible, for the long term.

All four functions remain valid and of fundamental importance today and for the foreseeable future. Taken together, they also mean that effective scholarly communication helps to build and sustain research communities. Until recently, publishers have served as providers for all key functions, with libraries also participating in the dissemination and the important task of preservation of scholarly outputs.

In recent decades, the **evaluation** of research has emerged as an additional function of scholarly communication because research institutions, funders, publishers, and researchers themselves have looked for mechanisms that can underpin judgements about scholarly merits or significance, as well as their wider impact. As will be seen later, however, the evaluation function is one of the most contentious aspects of scholarly publishing.

In an online digital environment, the ease and immediacy with which information can be produced and transmitted across the world implies that these key functions can be fulfilled by other means and distributed differently among the various actors involved in scholarly communication. Consequently, current developments in scholarly communication and publishing are characterized by shifting roles, opportunities and challenges, as will be seen later in the report.

A Vision for the Future

The Scientific Revolution of the 17th century speeded up the process leading to the elaboration of distributed knowledge networks. This movement can be likened to the process leading to the "world brain" outlined by H. G. Wells in the 1930s.[24] Wells' vision rests on all human beings partaking in some fashion in all the world's knowledge. Because knowledge is accessible to all, researchers as well as other individuals, all across the globe, can become active participants in a worldwide structure of distributed intelligence. This powerful metaphor provides for a vision of an ideal state of scholarly communication:

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[23] Robert K Merton, *The Sociology of Science: Theoretical and Empirical Investigations*. University of Chicago Press, 1962.
[24] See above, footnote 1.

barriers or delays in the transmission of signals to and from individuals will have disappeared, thus unleashing the full capacity and efficiency of the emerging world brain.

Scholarly communication can thus be guided by a set of principles that we outline below. These principles also allow us to scrutinise the instruments of scholarly communication that are now dominant, in particular journals: we believe scholarly communication needs to evolve more open, agile, and dynamic vectors of knowledge in which all kinds of documents, data and other materials can be flexibly interlinked and quickly submitted for comment and testing during the course of the research process. Should not these new vectors be allowed to evolve into part of a distributed, interoperable infrastructure that would provide high-quality tools to support researchers in all of their activities[25]?

Researchers and their needs must be put at the heart of scholarly communication of the future. This scholarly communication system must support and facilitate the use of knowledge and understanding for as wide a range of participants as possible, with as wide a range of purposes as possible, including its integration into new lines of investigation and new forms of education. Also, global social benefits should never be forgotten, which means that the optimal design of scholarly communication systems must include immediate, and universal access not only for the scientific communities, but also for society at large.

In the scholarly communication system of the future it is therefore essential that **knowledge and understanding created by researchers should be treated as public goods**, available for the benefit of members of society as a whole, to enhance the well-being of human beings across the planet.

We use the following **PRINCIPLES** to articulate our vision for the future of scholarly communication, as well as examine its current status.[26]

Maximizing Accessibility	**Community Building**
Maximizing Usability	**Promoting High-Quality Research & Its Integrity**
Supporting an Expanding Range of Contributions	**Facilitating the Evaluation**
A Distributed, Open Infrastructure	**Promoting Flexibility & Innovation**
Equity, Diversity & Inclusivity	**Cost-Effectiveness**

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[25] See "Open Science 2030 – A Day in the Life of a Scientist, AD 2030", available at https://ec.europa.eu/research/swafs/pdf/pub_open_science/open_science_2030.pdf.
[26] These principles draw on, but are different from, the Vienna Principles adopted by the Open Access Network Austria in 2016.

1. Maximizing accessibility

The need for effective dissemination implies strong efforts to make the results of scholarly work easily discoverable and openly accessible to anyone with an internet connection; and to enable readers and users to disseminate results further in a variety of ways, including non-digital formats. Dissemination is one of the key functions of scholarly communication, and is fundamental to the interests of both authors and users of information. Authors are eager to ensure that their work achieves as wide a distribution as possible, not least to secure maximum reputation and professional rewards for it. Wide dissemination is now much easier and cheaper via the internet than it was in the days of print.

While the volumes and kinds of outputs from research continue to increase, searching for information has generally become easier and more efficient. However, it has also raised issues of information overload. In an ideal state, content would be made easily-discoverable, and navigation tools could link a broad range of content in a wide variety of ways. Navigation and discovery tools could help identify aspects of the quality of the content and its relevance to some precisely specified context. Gaps and barriers – financial, legal, organisational and technical - between discovery and access would be eliminated. Potentially-relevant content, once identified, would be accessed in one or two clicks; it could be re-used and redistributed subject only to the norms of scholarly behaviour, while keeping in mind social benefit and the public good. Researchers, students, other interested individuals would all have full rights to do so. Once made public, the findings of research should, by default, suffer no delay in being freely accessible and re-usable, along with all related and relevant material.

2. Maximising usability

Publications and the data and materials surrounding them should be readily usable and understandable (by machines as well as people). Intellectual value diminishes if technical and legal barriers limit the uses to which content can be put. In an ideal state, users – aided by machines - would be able freely to reuse, share and modify, both individual content items and broad collections of content. A well-designed infrastructure based on open standards would provide a wide range of interoperable tools based on free and open software to facilitate use, analysis and re-purposing of various research outputs, including data. Licensing restrictions, if needed, should be limited to preserving important social values, such as privacy. A broad, international, network of public institutions would oversee the necessary effective mechanisms for the active stewardship and preservation of all the outputs of research for the long term.

3. Supporting an expanding range of contributions

With the digital revolution, researchers are producing and using data and other outputs in unprecedented volumes and variety. Additionally, born-digital outputs at all stages of research are acquiring increasing significance amongst research communities. In an ideal state, data, associated materials and other research contributions would be registered, certified, disseminated, preserved and evaluated on the same footing as formally-published texts reporting on research findings. They would also conform to the FAIR (Findable, Accessible, Interoperable, Reusable) principles[27] to ensure longevity and re-usability. As wide a range of contributions would be made accessible and usable as early as possible. In this fashion, they would be open to commenting, testing and amendment, thus enhancing the building of research communities.

4. A distributed, open infrastructure

Researchers must be able to rely on a globally interconnected infrastructure that fully responds to their needs both as readers, and as knowledge producers. Within this

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[27] See https://www.go-fair.org/fair-principles/ and https://publications.europa.eu/en/publication-detail/-/publication/7769a148-f1f6-11e8-9982-01aa75ed71a1/language-en/format-PDF/source-80611283.

infrastructure, elements essential for the function of the core system should remain in public hands, while different kinds of services could be provided by a range of organisations and initiatives, both public and private. In an ideal state, the infrastructure would remain totally open, and services would remain widely distributed, so that no single organisation could achieve undue dominance over the communication system on which researchers rely. Openness, as part of the governance of the infrastructure, is crucial to ensure responsiveness to changing needs. Barriers, therefore, should be minimised, so that services could be invented, aggregated, disaggregated and reorganised in new ways. Researchers would be active contributors to shaping tools and services by a system of rewards and incentives that would take such contributions into account.

5. Equity, diversity and inclusivity

Universality is one of the fundamental norms of science introduced by Robert Merton. It refers to the possibility for anyone to contribute to the production of scientific knowledge irrespective of ethnic background, religion, or political beliefs, but also gender and other potential sources of discrimination. This principle emphasises the importance of equitable contributions to shaping that knowledge.[28] In effect, this norm covers the need for promoting diversity, equity, and inclusion in the future state of scholarly communication, to break down structural disadvantages, and to avoid entrenched societal biases.

In an ideal state, policies and practices would be implemented, along with incentives, to ensure that those currently underrepresented would have equal chances to participate in the production and use of knowledge. This includes the opportunity to frame questions that, absent this concern, would remain neglected or insufficiently studied. Beside equitable access to and participation in knowledge production and dissemination, this principle also stresses the importance of diversity on the side of providers and operators of scholarly infrastructures.[29] This implies plurality of approaches sensible to the needs of research communities and the public, as well as balancing the interests of all participants against excessive dominance and consolidation of power among a very few. It also supports the production and dissemination of knowledge as a public good.

6. Community building

Membership and participation in research communities is essential for researchers: they want to see their work widely shared and recognised, and to draw on the work of others for their own research. A distributed knowledge network depends on continuing and vigorous discussions as different individuals and groups approach questions and problems in different ways. Effectiveness and speed of communication within and between research communities are vital to both cooperation and competition, and there should be no barriers to rapid and effective research communication.

In an ideal state, global networks of colleagues would balance the quest for speed with attention to integrity and reliability. Researchers would collaborate in projects and disseminate and (re)use research findings not only within their local communities but more widely. Building and sustaining research communities, and supporting communication and connectivity between different communities, would be recognized and rewarded as ways to enhance the reliability and integrity of the scholarly process.

7. Promoting high-quality research and its integrity

Certification is a critical element in scholarly communication: it ensures that research meets community-agreed standards of quality and integrity. It is related to Merton's norm of 'organised scepticism'.

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[28] See also https://ocsdnet.org/manifesto/open-science-manifesto/
[29] See also Jussieu Call for Open science and bibliodiversity: https://jussieucall.org/jussieu-call/

Peer review has become fundamental to certification; it is a process to which the research community is deeply attached as a quality filter. It aims at ensuring that research is technically sound and that mistakes can be identified and rectified; that the research process is fully-evidenced, and the findings properly presented; that the research meets relevant ethical and reporting standards; and that evidence of malpractice is acted upon. The forms and practices of peer review have been changing significantly over the past half-century, in a quest not only for scholarly rigour, but for transparency, fairness, and the avoidance of bias or conflicts of interest. However, peer review has also expanded into the area of evaluation of research contributions, by examining aspects such as novelty and impact of works.

In an ideal state, certification and quality assurance would come to rest on entirely transparent peer review procedures which, moreover, would be regularly reviewed and modified in response to changing needs. Unlike pre-publication peer review, which blocks the immediate release and rapid sharing of findings, certification would naturally follow the registration of successive versions of all kinds of research outputs and findings. Peer reviewers would be properly recognised as important contributors to a line of research. The scholarly record would include not just a version of record, but a *record of versions* of all the different kinds of contributions produced.

8. Facilitating evaluation

Judgements have always been based on a number of criteria, including intellectual significance within a field; relevance to a key research question, issue or problem; or impact and reach beyond the research community[30]. Using a range of criteria is necessary because the intellectual value of any research cannot be reduced to a single metric. In an ideal state, evaluation would encompass the full range of research contributions, including the individual contributions that researchers make to collective pieces of work[31]. It would be sensitive to the requirements of different disciplines and kinds of research, and would employ an appropriate broad range of tools and techniques. The criteria, the methodologies, the benchmarks, the data and the metrics that underlie judgements would be transparent and fair; they would be diverse, qualitative as well as quantitative; they would be kept under regular review and revised where necessary; and they would take account of the varying needs of researchers, their employers, funders, and other users. In other words, they would be fit for purpose.

9. Promoting flexibility and innovation

Responsiveness to the needs of researchers working in different disciplines and subjects, in different institutions and contexts, and on different kinds of research, demands flexibility and diversity: what works for one field or domain, or part thereof, may not work for another. There is thus a need for an appropriate balance between standardisation and meeting the needs of specific communities. In addition, there is a need for experimentation and innovation in the scholarly communication system - in social as well as technical aspects - in order to exploit new opportunities and to respond to changing needs.

In an ideal state, there would be regular dialogue between different research communities and specialists in design processes and socio-technical aspects of scholarly infrastructures, and with the full range of service providers and agents in scholarly communication. Services would be revised and reconfigured as a result. There would be a regular flow of new experiments and new entrants; and members of different research communities would

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[30] The ways in which scholarly contributions are evaluated long remained a blind spot among historians and sociologists of science. An important, early paper is Harriet Zuckerman and Robert K. Merton, "Patterns of Evaluation in Science: Institutionalisation, Structure and Function of the Referee System", *Minerva* 9, no. 1 (January 1971), 66-100.

[31] This is sometimes named "contributor roles". Compare the CRediT, the Contributor Roles Taxonomy, which has been widely adopted by a range of publishers, https://casrai.org/credit/.

be engaged in ensuring that value and effectiveness, scalability and sustainability are tested fairly and transparently.

10. Cost-effectiveness

Scholarly communication must be as cost-effective as possible, and this includes harnessing and leveraging the potential of digital technologies. Cost-effectiveness is a key issue for all the actors in scholarly communication, and for the health of the whole ecosystem: income for service providers – whether public, not-for-profit or commercial organisations – are costs for other actors, who need to be able to sustain them. Cost-effectiveness involves assessments of costs in reference to a range of activities and services. It is related to, yet different from, pricing - a distinction all too often neglected in discussions around the economics of scholarly publishing.

In an ideal state, costs, price settings and revenues would all be transparent, along with the financial flows between all parties. There would be clearly defined relationships between those costs and the kinds and levels of service provided, and services should be affordable to the buyers. New systems and processes significantly different from those inherited from the past could have the potential to reduce the costs of core activities and services. Income to support services would come from a range of sources; and research funding schemes would be designed to support experimentation and an enhanced range of services to meet the changing needs.

CHAPTER 3. SOME KEY SHORTCOMINGS

Using the principles defined earlier as a framework, this chapter sets out to discuss some key shortcomings of the current scholarly communication system.

Regarding the overarching principle of scholarship as a public good, the Finch Report put it as follows: "The principle that the results of research that has been publicly funded should be freely accessible in the public domain is a compelling one, and fundamentally unanswerable"[32]. For their part, funding agencies are increasingly concerned that restrictions on access to, and reuse of, research findings are incompatible with the benefits they seek to achieve: to advance knowledge, and to enhance public welfare.

In practice, however, the findings and results of research are not always or spontaneously treated as public goods. Much of the material produced by researchers – data, software, protocols and so on, which are often critical to the understanding and interpretation of the findings – is never made accessible beyond the ambit of the teams that created them. And most of the findings that *are* published are treated, in economists' terms, not as public goods but rather as club goods: although non-rivalrous, access to club goods is granted exclusively to those who have paid for it, or enjoy some form of access that is restricted to them.[33]

1. Maximizing accessibility

Accessibility includes both access and discoverability. Maximising access means removing all the barriers, technical, restrictive (such as embargoes) and financial, that can impede the use and re-use of registered knowledge. Embargoes obviously limit access for those with no access to subscriptions. Maximising discoverability requires bringing research to the attention of researchers (and others) to whom it is relevant and of value. The delays between submission and the publication of articles tend to hinder rapid and effective communication. The complexity and variability of the scholarly communication landscape is challenging, and may at times hinder, rather than help communication between researchers.

The efforts made across the globe in recent years to increase the amounts of scholarly content in open access have had a certain degree of success: some reports suggest that a quarter of all scholarly articles are openly accessible[34]. Other reports suggest that for the research-intensive countries as much as 50% of articles are publicly available.[35] Nevertheless, subscriptions and other barriers mean that a large proportion of scholarly content can still be difficult, and expensive, to access for many potential readers and users, especially those without access to institutional subscriptions.

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[32] "*Accessibility, sustainability, excellence: how to expand access to research publications. Report of the Working Group on Expanding Access to Published Research Findings*", June 2012. Accepted July 16, 2012. Open access advocates, however, do not ask that research results be placed in the "public domain" as defined in copyright law.
[33] Jason Potts, John Hartley, Lucy Montgomery, Cameron Neylon & Ellie Rennie, *Prometheus*, vol. 35 No 1 (2017), "A journal is a club: a new economic model for scholarly publishing", 75-92. DOI: 10.1080/08109028.2017.1386949.
[34] Piwowar H, Priem J, Larivière V, Alperin JP, Matthias L, Norlander B, Farley A, West J, Haustein S. 2018. The state of OA: a large-scale analysis of the prevalence and impact of Open Access articles. *PeerJ* 6:e4375 https://doi.org/10.7717/peerj.4375.
[35] These proportions do not take account of illicit postings on sharing sites, or of articles harvested by the illegal Sci-Hub site. See Universities UK (2017) *Monitoring the Transition to Open Access.* Science Metrix (2018), for its part, estimates that most of the leading countries in research have more than 50% of their papers legally available *gratis* on the Internet. See *Analytical Support for Bibliometrics Indicators. Open access availability of scientific publications*.

Discoverability and navigation of research outputs have improved with the development of portals, platforms and related analytical tools; with more comprehensive databases and search engines; and with better (machine-readable) metadata. But interoperability issues remain. Proprietary and commercial services, often for competitive reasons, tend to remain fragmented, while researchers seek comprehensive coverage. The journey from discovery to access of journal articles and other scholarly resources remains beset with blockages and false trails for many users[36]. Finally, research outputs are much less discoverable and accessible for advanced research activities, such as text and data mining because of usage restrictions imposed by some publishers. In short, present intellectual property laws are not well adapted to the needs of researchers and other users, and, as a result, they work less efficiently and effectively than they might otherwise do. This has a cost for the whole of society[37].

2. Maximising usability

Making both publications, and the data and materials surrounding them, readily usable and understandable (by machines as well as people) implies standardised metadata, essential contextual information, and community norms for such data. It also implies the development and adoption of open standards and measures to enhance interoperability. Keeping in mind the lessons learned from the internet, distributed and networked solutions involving open standards will prove both more agile and more robust than centralized, proprietary solutions.

As the example of journal articles shows, only a minority of journal articles – mostly, those published in open access journals – are made accessible to readers with licensing statements that grants them full and unambiguous rights to re-use or re-distribute them.[38] With repositories, usage rights for the different versions posted on different sites are often unclear, because they do not have a license specified. Moreover, inconsistencies in formatting restrict the potential for computational re-use of articles[39], and the lack of semantic context hampers information retrieval. In the future, these deficiencies may be compounded by the preservation issue: protecting digital content for the long term remains an unsolved problem, and the governance structure needed for such a project remains elusive.

3. Supporting an expanding range of contributions

Research workflows are now predominantly conditioned by digital tools, but the formats and scope of scholarly publications remain largely unchanged from the days of print, and progress towards new models that exploit the full potential of digital technologies has been slow. The obstacles to supporting the expanding range of contributions are technological as well as cultural. As G. Crane noted a few years ago, we live in an age of digital incunabula with the PDF format as its emblematic form[40].

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[36] Schonfeld, R C (2015) *Meeting Researchers Where They Start: Streamlining Access to Scholarly Resources* Ithaka S+R https://doi.org/10.18665/sr.241038

[37] After the European Parliament voted to change the copyright law, LIBER, the Association of European Research Libraries,, expressed its concerns. See https://libereurope.eu/blog/2018/09/12/european-research-innovation-at-risk-after-copyright-vote/.

[38] OASPA members show a predominant use of the Creative Commons CC BY licence: Redhead, C (2018) '*OASPA members demonstrate another year of steady growth in CC BY article numbers for fully-OA journals*' OASPA blog post, 18 June 2018, https://oaspa.org/oaspa-members-ccby-growth-2017-data/ See also the analysis of licensing in hybrid journals at https://subugoe.github.io/hybrid_oa_dashboard/about.html

[39] A number of groups and initiatives are seeking to address these problems: see, for example, JATS4R (JATS for Reuse) https://jats4r.org/

[40] Gregory Crane et al., "Beyond Digital Incunabula: Modeling the Next Generation of Digital Libraries," in *Research and Advanced Technology for Digital Libraries. 10th European Conference, ECDL 2006, Alicante, Spain, September 17-22, 2006. Proceedings*, vol. 4172, Lecture Notes in Computer Science (Springer, 2006), 353–66.

The means of distribution and access have changed. Some journals have in recent years introduced policies – and in a few cases associated workflows – to require or encourage authors to provide access to the data and other evidence that underlie their publications. But for the most part, articles remain disconnected from related research outputs; and arrangements to help authors in making data and related material accessible in accordance with the FAIR principles are typically awkward and onerous. It also remains rare for readers to be able to manipulate data and code directly from where they are published. Together, these limitations mean that current systems do not allow for the community-based replication and reproduction of results. Because the reward system for researchers is so strongly focused on the authorship of publications, they feel little need to address these problems, and incentives are rare and spotty. However, some funders now enable and encourage grant applicants to include in their applications references to a broader range of scholarly and societal contributions. Funders also increasingly require data management plans and sharing of data, as well as of other research outputs and contributions.

4. A distributed, open infrastructure

Some progress has been made in the development of open standards for the efficient exchange, aggregation and processing of data related to scholarly communication processes (metadata, links between research outputs, event data, text and data mining, etc.) through organisations such as NISO and groups of research institutions. Publishers have also collaborated in the improvement of metadata and associated services for example through Crossref and Datacite. There has also been considerable, and often public, investment (human, financial and other resources) in digital platforms and workflows. Examples include Open Journal Systems of the Public Knowledge Project, and the Coko collaboration involving EuropePMC, eLife, Hindawi, California Digital Library, and the University of California Press with infrastructures based on open source software. However, the interoperability of open platforms and workflows remains limited and too often subject to the inherent fragmentation of competing systems.

5. Equity, diversity and inclusivity

Current modes of access to and participation in the production of scientific knowledge are heavily shaped by structural inequalities at individual, institutional and regional levels. These range from invisible glass ceilings for career progression imposed upon female scholars, members of minorities and other under-represented groups, to self-perpetuating location advantages granted to work from high-prestige institutions or well-endowed countries, to certain research topics being neglected in mainstream publication venues and reward systems[41]. Such barriers to more diverse and inclusive participation stem from the hierarchic and competitive structure of research, which does not necessarily correspond with an equitable and distributed communication system. Who is given a voice and which knowledge is regarded as legitimate is largely decided by rankings that determine the powerful reputations of the top global research institutions and of the top journals. This situation can inhibit active flows of information between those privileged and others who are seen as less influential, or even peripheral, and thus stands in tension with the imperative to advance our knowledge and understanding of the world. Finally, APCs, like subscriptions, create a financial barrier hampering communication between researchers. They are particularly detrimental to lower-income countries - a point that should be kept in mind in view of the economic disparities affecting the member states of the European Community.

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[41] See e.g. Chan L, Kirsop B, Arunachalam S (2011) Towards Open and Equitable Access to Research and Knowledge for Development. PLoS Med 8(3): e1001016. doi:10.1371/journal.pmed.1001016.

6. Community building

The digital (r)evolution continues to affect all the processes, workflows and behaviours associated with research, including community-building and the links between researchers. All journals seek visibility and prestige, but some journals, such as society journals also seek a different and important objective - namely the development of research communities as a key part of their work. This second goal has been much strengthened: for example, facilities for commenting on, and annotating, articles are emerging, as are emerging new, open, forms of peer reviewing. Platforms are increasingly playing an important role beside journals. Communities, as a result, also emerge around such devices, e.g. disciplinary preprint servers and code servers (e.g. via Github). Platforms like ResearchGate also foster this kind of community building[42]. In short, many forms of commenting and discussion are developing outside the traditional structures of scholarly communication, still largely tied to the journal, but these developments need to be monitored and integrated in the communication system in better fashion.

7. Promoting high-quality research and its integrity

Certification is typically provided through peer review and various other processes of quality assurance are managed at the editorial level and/or by publishing staff. As previously noted, the research community is strongly – and rightly – wedded to the principle of peer review, but there are widespread concerns about the many different ways in which it operates in practice.

There is a degree of disquiet about bias and unprofessional behaviour, both in individual cases and at more systemic levels. There is also unease about outright failures in peer review, when research is published which does not meet recognised scholarly standards. The high rejection rates of the journals deemed to be most prestigious can also lead to excessive levels of competition. When retraction is needed, journals, institutions and researchers do not always react rapidly and decisively to clean the scholarly record. Reproducibility of research work is another source of concern. Attempts are being made to address these problems: many journals as well as funders seek to improve the transparency of peer review, but more needs to be done to ensure that research conforms to high standards of scholarly quality and integrity.

In part, these difficulties also stem from peer review playing two different functions: besides examining the rigour of the work, peer review also assesses the scholarly importance of the submitted work. However, when seen from the perspective of journals competing for visibility, scholarly importance easily translates into a degree of citability. This is one of the consequences of relying on journal prestige and visibility (as measured by citations) to evaluate research and researchers[43].

8. Facilitating evaluation

In the current economy of scholarly credit, the JIF, despite warnings and criticism by virtually all categories of actors involved in scholarly communication, has come to be treated as a kind of common currency that can be applied to journals of all disciplines. It has become a major metric on which evaluations of individual researchers, teams, departments and even whole institutions are partially based. It was not designed for this purpose, but its influence has become pervasive, especially in the physical and life sciences and in engineering: in particular, it skews researchers' choices as information creators when they decide on what to investigate and where to publish their research[44]; and it also

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[42] Richard Van Noorden, "Online Collaboration: Scientists and the Social Network," *Nature* 512, no. 7513 (August 13, 2014): 126–29, https://doi.org/10.1038/512126a.

[43] Björn Brembs, "Prestigious Science Journals Struggle to Reach Even Average Reliability," *Frontiers in Human Neuroscience* 12 (February 20, 2018), https://doi.org/10.3389/fnhum.2018.00037.

[44] Sarah de Rijcke et al., "Evaluation Practices and Effects of Indicator Use—a Literature Review," *Research Evaluation* 25, no. 2 (April 2016): 161–69, https://doi.org/10.1093/reseval/rvv038.

influences their behaviours as users, when they select what to read. It can also skew the selection processes of editors and peer reviewers[45], when the quest for citations competes with the concern for quality, particularly when an article is regarded as too innovative or unusual, deals with a neglected area of research, or is regarded as very novel and/or impactful. Important local or regional journals are often excluded from the citation databases Web of Science or Scopus, as the example of the Scientific Electronic Library Online (SciELO) initially launched for journals in Latin American and Caribbean countries has experienced in the past[46]. But the JIF's continuing influence on recruitment and promotion decisions, and also on success in winning research grants and awards, means that researchers, institutions and funders too often feel that they cannot afford to ignore it[47]. The salience of the JIF endows this single metric (and the company that oversees it - Clarivate Analytics - with an unhealthy power over the research ecosystem. While other metrics have been developed, some based on citations at journal level, like the JIF, others on alternative metrics of usage, networking and media impact, none has as yet seriously undermined the dominance of the JIF.

Regarding the use of metrics in general, it should be emphasized that outlet-based metrics should never be used as a proxy to evaluate the performance of individuals or single works; quantitative article-level based metrics should never be used as a sole proxy, but only to support qualitative judgements[48]. Concerns are being increasingly expressed about the need for metrics that are sensitive to differences between subjects and disciplines. Greater transparency is needed in the collection and analysis of the data on which metrics are based, to allow for verification; and for regular scrutiny and review of metrics, their use and effects. Thus, no single metric should be treated as conclusive, but rather as one of a suite of evidence to provide a more rounded picture. Research evaluations should never be based on metrics alone, but on expert assessments supported by a portfolio of evidence appropriate to the purpose, a view also supported by the OSPP Working Group on Rewards on Open Science[49]. The message is clear: certain characteristics of the scholarly communication system may be helpful for evaluation, but the present use of metrics, largely based on citations garnered by journals, leads to rankings, and these point to perceived prestige rather than quality.

9. Promoting flexibility and innovation

The opportunity for multi-layered transformation in scholarly communication offered by the transition into the digital world would seem to require a constant flow of innovations, experiments, field-tests, etc. However, a small number of large publishers, indexers and aggregators have increased their dominance in the provision of scholarly content and services, using commercial and technical tactics to maintain or even increase their market share. As a result, concerns have risen about vendor lock-in and the barriers to new

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[45] See, for example, Cowley, Stephen J. "How Peer-Review Constrains Cognition: On the Frontline in the Knowledge Sector." *Frontiers in Psychology* 6 (2015). https://doi.org/10.3389/fpsyg.2015.01706.

[46] W. Wayt Gibbs, "Lost Science in the Third World," *Scientific American* 273, no. 2 (1995): 92–99, https://www.jstor.org/stable/24981594. Rogerio Meneghini and Abel Packer, "Is there Science beyond English?", EMBO reports (2007) 8, 112-116. DOI 10.1038/sj.embor.7400906.

[47] There is considerable literature on this topic. See, for example, Bruce Alberts' editorial in *Science*, "Impact Factor Distortions", *Science*, vol. 340 (May 17th, 2013), 787.10.1126/science.1240319.

[48] Hicks, D. et al (2015) The Leiden Manifesto for research metrics *Nature* 520, 7548 https://www.nature.com/news/bibliometrics-the-leiden-manifesto-for-research-metrics-1.17351 ; San Francisco Declaration on Research Assessment https://sfdora.org/read/ ; Wilsdon, J. et al (2015) *The Metric Tide*, HEFCE, http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2015/The,Metric,Tide/2015_metric_tide.pdf. Dora is presently collecting good assessment practises: https://sfdora.org/good-practices/research-institutes/.

[49] OSPP Working Group on Rewards under Open Science, Evaluation of Research Careers fully acknowledging Open Science Practices. Rewards, incentives and/or recognition for researchers practicing Open Science. (EC, Directorate General for Research and Innovation, July 2017), p. 13. https://doi.org/10.2777/75255

entrants seeking to effect significant changes in the overall landscape. Moreover, new entrants, when apparently successful, have regularly been acquired by large publishers and other service providers.[50] While such acquisitions may have facilitated innovation in some cases, they may also have been carried out to control the pace and orientation of innovations. Some publishers, learned societies, universities, funders and others have actively sought new ways to exploit the technologies and affordances of the digital revolution. But the uptake of innovation by these institutions has tended to focus on fitting traditional forms of scholarly communication, especially journal articles and monographs, to the new technologies. By contrast, the very kinds of informal sharing practises that digital technologies have facilitated have been explored mainly by groups of innovative individuals, but with relatively little effect on the general system of scholarly communication. New technologies or innovative individuals are not enough to inject flexibility into the scholarly system of communication, and actors such as funders must examine whether they leverage their considerable financial resources as fully as they should.

10. Cost-effectiveness

In seeking to fully realize the potential of digital technologies, scholarly communication must involve efforts on the part of all actors – research institutions and their libraries, funders, publishers, as well as researchers themselves. With the advent of computers and the internet the expectations were that the costs of production, storage and dissemination would decrease in very significant ways. Yet, prices have continued to climb, partly because the number of contributions continued to grow, but mainly because the pricing of scholarly publications is not related to the costs of production in any clear fashion. Well-managed and regulated, transparent and competitive markets should provide pricing relief, but scholarly publishing stands somewhat obliquely with regard to market forces[51].

Competition within a market has meaning only if the nature of this competition is clearly understood and correctly applied to the situation under analysis. In scholarly publishing, from the perspective of both authors and readers, articles are not substitutable. Even when articles compete to provide the ultimately accepted solution to a problem, this kind of competition points to the selection of the stronger thesis to be preserved in the scholarly archive and the collective memory, rather than to some progression in "market shares". Identifying the best quality in research articles does not coincide with finding which journal enjoys the largest number of citations.

The situation just described is exacerbated by a lack of transparency around true costs of publishing, enabled by the exercise of control in academic publishing by a few companies: non-disclosure agreements between publishers, on the one hand, and research institutions and their libraries, on the other, maintain price opacity.

Part of the solution to the question of improving scholarly communication is undoubtedly linked to the development of new systems, quite different from those inherited or adapted from the recent past, but technology alone will not suffice. The ways in which money flows, according to what rules, and toward which actors are also important factors in this discussion. Competition, whenever it applies, should be for services supporting scholarly communication, not for citability of content, and it should be accompanied by transparency around the costs associated with these services. There is also the need fundamentally to reform the role that journals play in research evaluation.

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[50] Larivière, V., Haustein, S., & Mongeon, P. (2015). The Oligopoly of Academic Publishers in the Digital Era. PLOS ONE, 10(6), e0127502. doi:10.1371/journal.pone.0127502
[51] Albert N. Greco, "Academic Libraries and the Economics of Scholarly Publishing in the Twenty-First Century: Portfolio Theory, Product Differentiation, Economic Rent, Perfect Price Discrimination, and the Cost of Prestige," *Journal of Scholarly Publishing* 47, no. 1 (October 2015): 1–43, https://doi.org/10.3138/jsp.47.1.01.

Final remarks

Little has been said in the previous pages about the peculiar difficulties faced by the social sciences, the humanities (SSH), and the life cycles of their prime intellectual currency – monographs. The rising cost of science, technology and medicine journals (STM) journals has often been met by reducing the acquisitions of SSH monographs thus decreasing their accessibility but also making it more difficult to publish them. Offering new ways to publish significant SSH results, and connect them with the reward system of these disciplines is of great importance.

SSH disciplines have also maintained non-quantitative forms of research evaluation, thus demonstrating that such practises are not only possible, but also effective. Other disciplines may find interesting ideas and processes to move beyond the present focus on a one-metric system.

If the scholarly communication ecosystem is to conform to the principles outlined in chapter 1, the current – strongly-entrenched – culture of rewards and incentives for researchers needs to be modified, but this is hardly a new thesis: institutions must also change. In particular, funding agencies should closely study the distortions of an evaluation system based on citations on the research efforts and their outcomes: do the published works really correspond to the subsidized project programme and its original orientations and objectives?

At present, incentives for most scientists still focus on publication in high-prestige journals, with status measured by rankings based on the JIF. Funders, institutions, and researchers themselves, as well as publishers, are all complicit in the prominent weight they attach to this measure, but researchers have less manoeuvring room than funders or even research managers in decisive roles. In a complex set of self-reinforcing relationships, the impact factor metric and the thinking surrounding it has profound effects on the selection of applications for research grants, recruitment and promotion of researchers, and the development of research partnerships and careers. It also affects the strategies, business models and operations of all scholarly publishers.

Recent moves, following the San Francisco Declaration on Research Assessment (henceforth DORA) and the Leiden Manifesto, to promote a more inclusive set of criteria and mechanisms for assessing research performance and potential, may presage some change in the current culture. If that were to happen, it would have profound impacts on all the players in the scholarly communication – indeed in the research - ecosystem. More than technology, the socio-cultural practices around evaluation of research is what lies at the heart of the problems faced by the present system of scholarly communication and publishing. Thus, social innovation is at the core of needed reforms.

CHAPTER 4: KEY ACTORS: PERSPECTIVES, ROLES AND RESPONSIBILITIES

It is the central thesis of this report that researchers stand at the centre of the scholarly communication and publication systems. However, much more is needed to complete the picture of scholarly research activities: it requires considering all the key actors involved, including research centres, in particular universities (and their libraries), funding agencies and policymakers, both public and private, publishers of all stripes, and citizens called out by scholarly activities for personal, collective, professional or political reasons. Each of these actors display specificities that account for their positioning relative to each other.[52]

Advances of digital technologies offer new possibilities for actors to perform one or all of the functions in scholarly communications. This means that traditional boundaries, activities and roles of actors become less distinct and/or come under question with existing actors either seeking to protect their roles or forge new roles, transforming themselves at the same time (for example the libraries as publishers). Meanwhile, with the advances of digital technologies, new actors also emerge, often in the form of companies pursuing innovative goals, such as computer-assisted exploitation of various kinds of databases or document collections.

This chapter outlines the main lines of force structuring this complex landscape. Beside the fluidity and the changing nature of some of the main actors, an important trait of the landscape is the prominent role of open access as a standard for accessibility. It is also a component that significantly shapes the business models and the practises of key actors.

1   Researchers and research communities

Researchers play various roles: on the one hand, they are information seekers and users and, in that position, they tend to privilege communication with other researchers; on the other hand, they seek credit and are evaluated for their career. In that perspective, the more formal process of publishing becomes very important. Of course, publishing and communicating overlap, but this distinction generally holds up in researcher communities. In addition, it must be remembered that the means to communicate are far more varied and informal than the means to publish. They also tend to be much more inclusive.

Researchers' roles also vary according to their status and position. For an industrial researcher patenting may be preferable to publishing, while the reverse may be true of a researcher in a university laboratory. Senior researchers have more opportunities of being gatekeepers or judges than their less experienced colleagues. In particular, an important minority among them play a formal role in the publishing process either as members of editorial boards of journals, or as reviewers.

Researchers collaborate in teams within and across institutions, communities and countries, as well as between subjects and disciplines. At the same time, researchers also display strong competitive behaviour: originally limited to being first at solving a problem, competition now extends to many aspects of a researcher's life, for example funds for their work which obviously translate into advancement in their careers[53].

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[52] This report does not place an emphasis on industry and businesses as key actors of the scholarly communication system, unless their business directly contributes to it. On the other hand, it acknowledges the empowering forces of the open circulation of knowledge for innovation, the economic sector, and the global organisation of research.

[53] See, for example, Mary Jo Nye, "The Republic vs. The Collective: Two Histories of Collaboration and Competition in Modern Science," *NTM Zeitschrift für Geschichte der Wissenschaften, Technik und Medizin* 24, no. 2 (June 2016): 169–94, https://doi.org/10.1007/s00048-016-0140-9.

As users of research produced by others, researchers have a strong interest in effective dissemination and preservation: they need quick and easy access to all the findings that are relevant and of value to them. As producers of research whose evaluation affects their career paths, they are influenced in their publishing and other research dissemination behaviors, as well as patterns of collaboration and research design, by the requirements of the evaluation procedure set to them by their institutions, the funding agencies, and the targeted publishing venues. This currently means a heavy investment in journals with high JIF - a major element in performance assessment. On the other hand, releasing the results of their research in open access is less directly of value for their career. Experimenting with new modes of research dissemination lies further back in their considerations. If researchers must be placed at the centre of scholarly communication and publishing systems, it is clear that many researchers' interest in the scholarly publishing system is largely limited to two functions: communicating with their colleagues, and advancing their career. Researchers are generally insulated from the financial aspects of publishers because their access to journals, or to publishing in journals, is paid for by their institutions, their libraries, or their funders.

Working partially against this trend new technologies and services now enable researchers to take back some control over some elements of publishing, in particular registration and dissemination. They can, for example, ensure attribution to their own work by posting versions of their outputs on web-based and open access services such as an institutional repository, or a thematic repository such as arXiv and bioRxiv. In doing so, they maximise dissemination and accessibility to their own work by themselves.

Researchers depend on other researchers to certify and evaluate their work, but peer review brings delays and raises other issues, as discussed in the preceding chapter. Such problems obviously constrain the ability of researchers to publish and, therefore, to gain proper credit for their work. They may even affect the kinds of findings that are published: negative results rarely enter the scholarly record, for example.

Scholarly and learned societies, as well as researcher communities that look after the interests of their disciplines, are well positioned to affect change in all functions of scholarly communication. Their roles in advice and advocacy on matters relating to research policy and good practice (for example open science practices), and in recognising and rewarding high-quality work, mean that they are also in a good position to promote change in the mechanisms of peer review and quality assurance that underpin **certification** and **evaluation** in the scholarly communication process. However, their influence will be much increased if they link up with equivalent societies across national boundaries, in line with the trans-national tendencies of scholarly research, and to face up to continental or even global challenges such as a pandemic.

2   Universities and research institutions

In supporting their research and their educational missions, universities seek to foster the development of scholarly communities and environments in which research and knowledge can flourish. Universities also seek to disseminate this knowledge to the research communities and society at large.

Like researchers, universities are both co-operative and competitive. Competition has been exacerbated by the recent introduction of funding mechanisms that rely on quantified evaluation criteria. Such procedures generally privilege rankings over multi-dimensional institutional profiles and other, more general, forms of reputation. This trend has also affected the ways in which faculty and students have been recruited, as the goal has become to respond to the assessment requirements with the solutions that maximize funding flows.

Universities seek to maximise the dissemination and impact of their research but, in the last fifty years, they have partially and gradually disengaged from their roles as publishers. The only exceptions relate to the humanities and social sciences, where university presses still play a visible role, and to the few cases where universities own robust and long-lived publishing presses that are also competitive in the commercial sphere. Digital technologies and the quest for open access to knowledge have brought to the fore the renewed possibility for the university to assume some or even all of the functions in scholarly communication with the libraries and university presses as focal points. Libraries are now involved in publishing initiatives and in establishing new open access university presses; they set up and maintain repositories where faculty research can be registered, preserved for the long-term and made available to the broader public, and they can contribute to the certification of knowledge produced in their research institution. Further, libraries have long supported open access to research and many among them have helped to develop open access institutional policies. They have also contributed to a cultural change amongst researchers, and to a re-alignment of universities with their mission to circulate knowledge within their society and beyond.

In conclusion, universities are in a position to perform all the basic functions of scholarly communication because they are the focal points where research is produced and further re-used; because they benefit from strong support systems, particularly through their libraries, their presses, and their IT services; because they already network with other universities on a global scale. Digital technologies, especially in their free and open form, allow them to design, maintain, evolve and control their own dissemination tools. They also train the computer scientists and professionals needed to design and work the new technologies and socio-technical systems. However, to achieve these objectives, universities and research centres need to solve some social, institutional, and ultimately political problems, among which the need not to give in too much to a competitive spirit that also fosters divisions, isolation, and the temptation to outsource basic functions and services. Even within a generally competitive context, universities and research centres have shown that they can define pre-competitive, forms of collaboration on infrastructural elements such as standards, protocols, etc.

3   Research funders and policy-makers

Research funders in both the public and charitable sectors support research for public good purposes. Funding of research as a public good implies a particular concern for quality, access and effective dissemination. Their role is vital to the health of the entire research ecosystem, and their policies and selection mechanisms are crucial in determining what research is actually done and how it is done. Research funders, therefore, can affect directly or indirectly all functions of scholarly communication, and have considerable power to promote change. In fact, in the present phase of history, they may well stand out as the most powerful agents of change.

Funders/national research agencies are often and directly involved in the evaluation of institutions. In a context largely dominated by the new public administration, they tend to base evaluation on a measurable performance basis designed to intensify competition, including in publishing, and they set the quantified parameters of such evaluations. They also organize evaluations of grant submissions on the model of peer review by seeking experts to select the best proposals as judged from the perspective of their funding programme. Funders have not been invested in the registration and certification functions of scholarly communication, but they could do so, and some are exploring their possibilities in this regard. Their main interest, on account of maximizing the benefits and efficiencies of research, has been on the dissemination function, while, more recently, they have also turned their attention to the preservation function of scholarly communication. In short, by developing policies and through funding publications, infrastructures and setting funding requirements, funders and policymakers influence research practises and institutions most powerfully.

Over the past two decades, hundreds of funders and policymakers around the world have established policies to promote and support open access to maximise the benefits of their investments for the public good. Increasingly, funders financially support open access to publications, as well as open access publishing: some do so by entirely or partially financing APCs for open access venues that charge per article, either through dedicated APC funds or by rendering APC costs eligible in grants. Some funders have provided financial resources to support open access publishing infrastructures and venues that do not charge APCs. This is the case, for example, in France, with Open Edition, in Canada with Érudit, in Latin America with Redalyc and SciELO. The European Commission also supports organisational and technological capacity-building of institutional publishing infrastructures across Europe, in particular for the Humanities and Social Sciences, by funding existing robust networks, such as the OPERAS network.

Funders, including the European Commission, also support the institutional management of research outputs and publications through repositories, by supporting interoperability through protocols and standards, as well as the cooperation among international repository networks both for publications, and data, for example through the project OpenAIRE. Importantly, the European Commission has supported and is funding the European Open Science Cloud, a federation of data infrastructures in Europe and beyond to provide seamless access to research data and services to all European researchers. Most recently, some funders – including the Wellcome Trust, and the Bill and Melinda Gates Foundation - have established their own publishing platforms, a move now emulated by the European Commission. [54]

These policies and initiatives have all had a powerful influence over the orientation of scholarly communication and publishing in general, and, in particular, the adoption of open access as a principle in scholarly publishing. The very recent announcement of Plan S by cOAlition S is a further example of how funders collaborate to accelerate progress towards comprehensive access to publicly funded research, and do so in a way that may also have a profound impact on publishing as a business. The move away from hybrid journals as outlined in Plan S' first announcement could have a profound impact on the journal market, since certain publishing models are being explicitly characterized as being non-compliant to Plan S principles. It may also have important effects on publishing behaviours among researchers.

Finally, funders have also been active in promoting the reform of research evaluation outlined in the Leiden Manifesto and DORA. All seven UK research councils, for example, have signed the DORA declaration, and cOAlition S has committed to fundamentally revise the incentive and reward system of science using DORA as a starting point.

4   Publishers and other scholarly communication service providers

Publishers, both commercial and not-for-profit, are presently the major service providers to researchers, universities and other research institutions, and funders, for all the key functions of scholarly publishing. As service providers, they are in competition with each other for journal market share. This competition is focused on the 'brands' of their journals (as expressed through strictly quantified rankings), the scope and efficiency of their services, and the effectiveness of their interactions with other actors mentioned in this chapter. Like other service providers, such as aggregators or abstracting and indexing services, their roles are at risk unless their services continue to be seen by those actors as valuable and trusted (and worth paying for). The last point is crucial and has been the centre of many controversies, particularly between libraries and publishers, since the 1980s.

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[54] A tender for a publishing platform launched by the European Commission in March 2018 led to a non-award of the contract, but a new tender has been announced here in November 2018.

As noted earlier, digital technologies have offered the possibility of disaggregating the key functions in scholarly communication and publishing. This means in particular that 'publishing' is gradually becoming a process involving an ever greater number of players, and it depends on the concatenation of many operations that can be distributed across many institutions and communities, with for-profit and not-for-profit actors participating. Thus collaborations in publishing initiatives and services in the for-profit and non-for-profit arenas are well-known and common. Most usually a traditional publisher may organize or support peer-review, and is responsible for the editorial part of publishing, while other companies may provide technology services. More recently new innovative companies may focus only on supporting one function of scholarly communication, for example only peer-review, while yet others provide services that measure the impact of research. Publishers are adapting their roles in response both to changing needs and to these new competing services which may involve researchers, universities and research institutions, as well as funders. Aside from their traditional roles in supporting quality assurance and peer review, publishers participate in numerous initiatives and develop services, often in partnership with universities and other organisations in support of scholarly communication, such as open standards or metadata standards (e.g. CrossRef and ORCID), indicators or services that seek to evaluate research (for example ImpactStory, Altmetric, Scimago and Plum Analytics).

In a different vein, some organisations seek to provide more integrated sets of services to support research workflows from research project development and inception, through to dissemination, preservation and evaluation of outcomes, including the various processes involved in performance management. Some larger publishers are active in such developments, as are some related companies such as Clarivate Analytics, the present owner of the Web of Science, but there are opportunities for other organisations – including universities and research funders - in developing platform-based initiatives of this kind. They are likely to have profound implications for the future of scholarly communications, especially when considering the consolidated management of data, and the problems raised by closed, centralised systems.

Business models, particularly those built around profits or surpluses (for some non-profit entities), are increasingly accompanied by new financing schemes, often supported by public and charitable money, or some combination thereof. The funding flows to support them have become much more diverse and complex, with significant differences not just between publishers, but also between countries and individual research funders, as already seen in the first chapter of this report.

5   Practitioners, Educators and other Social groups

A final set of actors is made up of users and providers of information whose interests are central to the public good purpose of research even though they are not always visibly or directly included in the research ecosystem. For analytical purposes, individuals and organisations may be divided into five overlapping groups. First, there are professionals, such as engineers, medical practitioners, policymakers etc. Second, there are those, such as patients, who need reliable research information to address particular circumstances or problems. Third, there are students and teachers who need access to research findings. Fourth, there are 'citizen scientists'. Fifth, there are the journalists who play a critical role in reporting and interpreting research and its results for the general public. Finally, there are the members of the general public (all of us) who wish to have some degree of assurance that the research supported by public and charitable sector funds is properly conducted, that the results are properly presented, and that proper and effective use is made of them.

A more effective system of scholarly communication and publishing will be much more open to this set of actors. what they can gain from, but also contribute to, the whole knowledge enterprise. In short, users in a more general sense could have more active roles

in scholarly communication even though their role in scholarly publishing is less clear. Many organisations and individuals in the public, commercial and not-for-profit sectors have an interest in accessing the results of research; and indeed the public at large has an interest in the effective production, dissemination and use of the knowledge, understanding and expertise on which the well-being of society depends. Hence it is vital that non-experts (who include professional researchers outside their specialist fields) should have opportunities to engage with research, learn from it, and even influence its orientations. These perspectives are important because a truly open ecology of scholarly communication helps to engender trust in research and its results. If that trust is lost, an age of scepticism may arise, with the risk that public support for the resources needed to advance knowledge and understanding will be lost too.

A first and most important barrier to the active participation of societal actors in the scholarly communication system is the fact that access to knowledge is still largely behind paywalls, and therefore not readily accessible by society at large.

Various obstacles currently hinder engagement of non-specialists with research and research contributions, such for example the intense use of technical language, the predominant use of English as the medium for research communication, or accessibility issues for people who are visually impaired or dyslexic, among others. Technical solutions, such as 'lay summaries', translation of findings in various languages, or tools for the visually impaired and other categories of challenged individuals, may help bridge this gap. It will also help understanding and engagement with research. Open access in its fullest sense (in particular removing any constraints on reuse) will help by removing legal and technical obstacles to translations, forms of display, and interpretations.

Conclusion

Within a complex landscape characterised by its fluidity and the changing nature of some of the main actors, funding agencies and research centres, including universities, are exploring ways in which to take on some of the publishing functions. Publishers, for their part, continue to service the needs of the research communities through innovation at each of the publishing functions, remaining the main providers of these functions. But they also try to keep their control over most of the publishing functions in order to protect or enhance the sustainability and profitability of their business model. Finally, some publishers are also exploring ways to re-engineer their business model around new tasks and services, for example around the various elements of the full research workflow, or around the opportunities offered by particular flavours of open access.

One main prediction can be made about the evolution of the scholarly publishing landscape: it is no longer whether open access will succeed or not since most actors have embraced some version of it; it is the form in which it will ultimately stabilise (at least, for a while) that matters now.

CHAPTER 5. MOVING FORWARD, STEP BY STEP: RECOMMENDATIONS TO KEY ACTORS IN THE SCHOLARLY COMMUNICATION SYSTEM

Our aim in this chapter is to identify steps that can be taken to make the 'world brain' operate more effectively in line with the vision presented earlier in this report. A number of issues have been identified as working against this vision. We are thus offering recommendations for each of the key stakeholder groups while keeping focused on the future effectiveness of scholarly communication. Whilst researchers, communities and organisations can all take action individually, these actions will be vastly more effective with concerted and collaborative approaches between the actors. Individually, we can influence the system; together we can transform it.

1   Researchers and research communities

The intensity of the competitive environment where researchers race against each other for funding and scholarly credit, discussed earlier in this report, constitutes the first barrier to change: researchers need and want to collaborate, but the current metrics used to evaluate research, most prominently the JIF, provide few incentives for cooperation.

A complicit behaviour with this competitive environment leads to an investment in scholarly-communication-as-it-is, and it has long constituted a second strong barrier against changes that could lead to more effective scholarly communication. Within such a competitive atmosphere, the public-good nature of research contributions can be easily forgotten; discoverability, access and usability are not maximised, and scholarly publishing falls short of the principles and the ideal state that have been outlined earlier. This partially explains why, after twenty-five to thirty years of intense deployment, digital technologies have done little to deliver its promises: the status of journals and articles has remained largely unchanged.

While the technological tools and capabilities currently available enable researcher-led initiatives towards a scholarly communication system that supports an effective world-brain, scholars often feel and perceive that they have little power to effect such change. But they can certainly do more than they do, and they can act both individually and collectively if they so choose. In fact, younger researchers have begun doing so in Europe, for example with the Global Young Academy (GYA) and the European Council or Doctoral Candidates and Junior Researchers (Eurodoc). Researchers at all career stages can support their libraries when the latter negotiate better financial and access terms to the scholarly literature. They can prioritise their work as editors or peer reviewers for journals that operate more in accordance with the principles of our vision outlined earlier[55]. They can resist the tendency to grant most positions on important committees and editorial boards mainly to senior researchers – a step that will most certainly aid diversity as well. They can work through learned societies, faculty unions, and other organisations to engage with funders and policy-makers, universities and research institutions, publishers, and other service providers. However, if the competitive context is so intense as to work against these issues by relegating them to insignificance, many researchers will continue to concentrate exclusively on their problems.

Researcher-led changes strongly depend on changes in the reward system: in particular, judgements over the value of research should be based directly on content rather than

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[55] The Public Library of Science open letter of September 2001 offers an early example of this attitude. It states the following : « To encourage the publishers of our journals to support this endeavor [archival record of science should be placed in an international online public library], we pledge that, beginning in September 2001, we will publish in, edit or review for, and personally subscribe to only those scholarly and scientific journals that have agreed to grant unrestricted free distribution rights to any and all original research reports that they have published within 6 months of their initial publication date. https://www.plos.org/open-letter.

venue, and should encompass the full range of research outputs, including data and code. It must be a priority to replace incentives that reward activities and behaviours inimical to the principles of an effective scholarly communications ecosystem and inimical to the practises of open science[56]. If a new and healthier balance is to be achieved between collaboration and competition, the quest for excellence, because it can be identified only through competition, must not systematically (and systemically) take the place of a concern for quality. This does not mean rejecting competition in all circumstances; it only means paying attention to the dangers of managing research exclusively through competitive procedures.

Researchers and research communities should:

1. When participating in research assessment, for example in hiring, promotion and tenure, and funding decisions, focus on the merits and impact of a researcher's work and refrain from the use of metrics - particularly journal-based metrics - as a proxy. In particular, they should incorporate the recommendations from DORA and the Leiden Manifesto into the assessment process.

2. Take responsibility for ensuring that all research contributions are made openly available, discoverable, and reusable according to agreed community standards (including the FAIR principles).

3. Increase awareness of, and sense of responsibility for, implications of choices and actions in roles as authors, reviewers and members of decision-making groups.

4. Strive for a balanced and diverse representation (in terms of gender, geography and career stage) when seeking collaborations, organizing conferences, convening committees, and assigning editors and peer-reviewers, and building communities such as learned societies.

5. Work towards increased recognition and appreciation of peer-review work as core research tasks. To this end, support greater transparency, including the publishing of signed reports. Support better training and inclusion, and focus on quality of the research in peer review[57].

6. In the case of communities of researchers, such as learned societies, develop policies and practices that support modes of scholarly communication in line with the vision outlined above. Along with universities, learned societies and other research communities need to alert and train their researchers to the importance and the responsibilities of communicating knowledge, either formally, through publishing, or through other means.

2   Universities and research institutions

Universities have always been key actors in scholarly communication in the context of their research and educational missions. In response to the changes wrought by the digital revolution, to the increasing volumes and varieties of research outputs, and to the growth of the open access movement and, later, of open science, many universities and other research institutions have established new scholarly communications policies and protocols, and new services. It is important that universities and research institutions should continue to develop their scholarly communication and publishing roles in a

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[56] See "Evaluation of Research Careers fully acknowledging Open Science Practices. Rewards, incentives and/or recognition for researchers practicing Open Science", ed. Conor O'Carroll et alii, Directorate General for research and Innovation, Open Science and ERA policy, July 2017. https://ec.europa.eu/research/openscience/pdf/os_rewards_wgreport_final.pdf.
[57] Publons and F1000Research are but two examples of sites where peer reviews can be included in a researcher's curriculum vitae.

changing landscape. Universities and research institutions should develop strategies for scholarly publishing that align to their missions as institutions and serve the public good. They should support the role of their libraries not only as access points to knowledge, but as important agents in all key functions of scholarly communication and publishing, while always keeping in mind the broader mission of the institution, which is to serve the public good.

The power of individual universities to promote widespread change across the scholarly communication ecosystem is obviously limited. It is therefore important that, wherever possible, they should act cooperatively in the spirit of contributing to open infrastructures. Examples of collective action are already evident in areas including *digital preservation*, with the networked consortium of libraries that is responsible for the LOCKSS initiative; and in other publishing functions such as registration, *dissemination*, etc., with the development of a wide range of open access and open science initiatives (e.g. OpenEdition or the Open Library of the Humanities). In Europe, organisations such as the European University Association (EUA), the League of European Research Universities (LERU), Young European Research Universities (YERUN) and the Association of European Research Libraries (LIBER) can play important roles in the development of services and initiatives across the full range of scholarly communication and publishing. Different universities will rightly pursue different strategies, but, crucially, they should also ensure that new and existing services operate explicitly as part of a distributed and open and network. This concern is all the more fundamental when taking on a publishing function such as certification, which would require the networking of a number of peer institutions to build an evaluation system that stands the test of objectivity, neutrality and rigour.

As the main actors involved in negotiating access to knowledge through the current publishing system, universities and research institutions need to work towards more transparency in the scholarly communication system when negotiating agreements for subscriptions and open access. They must be aware of the costs involved in publishing and accessing research for making informed decisions and they must refuse to participate in agreements that do not lead to transparent business interactions. This is, for example, the case with confidentiality agreements, which divide academic institutions against each other, and weaken their ability to negotiate in full knowledge of the prevailing conditions of the journal market.

This said, nothing will do more to foster change in accordance with the principles set out in this report than concerted work and institutional change in the area of rewards and incentives. In this area universities and research institutions are in a powerful position to ensure their alignment with the principles adumbrated earlier on, that will lead to a more transparent and fair evaluation system for researchers. Some universities have already indicated that they wish to change both incentive and reward cultures by adopting the principles set out in DORA and/or the Leiden Manifesto. More should do so, and, in assessing researchers and the value of their work, ensure that they fulfil in practice the principles set out in such statements.

Finally, the present structure of scholarly communication and publishing, again because of its extreme competitiveness, leads to a variety of choices that err on the side of caution and conformity to narrow research models. These traditional models tend to be white-and-male centric, and they tend to privilege well-established problems at the exclusion of true originality and innovativeness. Restoring a wider sense of exploration and a habit of thinking out of the box can be achieved only if rewards and incentives incorporate such objectives.

Universities and research institutions should:

1. Develop policies and practices to ensure that all research contributions are made openly available, discoverable, and reusable according to agreed community standards (including the FAIR principles).

2. Promote and implement the recommendations of DORA and the Leiden manifesto to ensure that research assessment takes into account a wide range of scholarly contributions including research articles, preprints, datasets, software, patents and materials (e.g. in hiring, tenure, and promotion decisions).

3. In deciding which infrastructures to use, support, and contribute to, choose platforms using free or open source software, offering open data via an open license, and leveraging open standards where possible. Acting in this fashion will also reinforce researcher-led initiatives that aim to facilitate scholarly communication and publishing.

4. Strive for a balanced and diverse representation including, but not limited to, gender, geography and career stage) when hiring, seeking collaborations, when organizing conferences, when convening committees, and when assigning editors and peer-reviewers, and building communities such as learned societies.

5. In negotiations with service-providers refuse non-disclosure clauses and include clauses which enable cost and price control, and compliance monitoring. Strive to facilitate collective action with other institutions by e.g. sharing cost and price data through joint initiatives (e.g. OpenAPC).

3   Research funders and policy-makers

Taking into consideration their mission and responsibility to look after the public good, funders and policy-makers have been active in issues revolving around scholarly communication and publishing, with an emphasis on the dissemination function, as seen in the previous chapter. Considering their powerful position to effect changes that can actually (re)shape scholarly communication, and in view of promoting research and supporting the public good, research funders and policy-makers should be closely following the possibilities opened by current developments in scholarly communication and publishing. They should also be assessing their potential future roles across all the functions of scholarly communication and publishing for the benefit of research and the public good through the development of relevant policies and requirements and by directly supporting capacity-building in areas of scholarly communication. They should also be assessing the potential roles of other actors in the system that they fund, also with the same principles in mind.

Funders are uniquely positioned to further develop strong and aligned policies and requirements that ensure that all research outputs they support are openly available to all and everywhere with no barriers whatsoever around the world. In addition, they are in the position to affect the shaping of a fair system for scholarly communication services, whereby research is made openly available at costs that are cost-efficient to paying parties within a transparent system. Such a system can include public and private service providers; funders, along with universities, should decide what should be handled by private companies, and what should be stewarded by entities devoted to the public interest, and at what cost.

Keeping the public good in mind, funders can gradually set a healthy balance between private and public activity, where services should support a system designed for the long term. Accordingly, funders and policy-makers should fund relevant services and infrastructures (for example for publishing functions or repositories, including platforms) with a long-term vision. They may choose to assume a publishing function themselves, for

example in developing their own publishing platforms. Funders could also have a role to play in the certification function of scholarly publishing: they have experience in organizing the review of scholars and their projects by their peers – in other words, peer review –. This experience can be directly applied to the certification function of scholarly publishing.

Alongside universities and other research institutions, funders are thus in a powerful position to promote change in evaluation, by making clear that their reviewers will look directly at content and not limit themselves to journal titles, and will take account of the full range of research contributions when they assess the track records of individuals and teams and their grant applications. They can also make clear that negative results and the verification of earlier findings are valued.

Finally, funders should re-evaluate the effects of competitive strategies on the kinds of research they support. Is competition always needed? Could not other processes based on quality threshold be designed? The consequence would be a greater range of possibilities, of innovation. Furthermore, the moving away from the obsession of competition would open some mental space to think in terms of greater diversity, greater variety, greater originality. Funders, through a careful attention to the criteria used in distributing funds, can certainly affect the types of research pursued and the openness of the whole process.

In all these areas, it is critically important that funders and policy-makers develop their policies and services in consultation with the research communities, while keeping a clear vision of their own objectives. Publishers and other service providers have their own evaluation objectives, which may or may not converge with the funders' own goals, but this can be assessed only if the publishers' approach to evaluation is transparent. For funders, relying on publishers criteria may lead them to substitute visibility or prestige to more fundamental issues of quality.

Research funders and policy-makers should:

1. Develop policies - along with appropriate funding mechanisms - to ensure all research contributions arising from their funding are available to everyone, everywhere, without any barriers to access or restrictions on reuse.

2. When evaluating researchers, ensure that a wide range of contributions (scholarly publications, but also data, software, materials etc) and activities (mentoring, teaching, reviewing etc) are considered, and that processes and criteria of evaluation are both appropriate to the funder's research programme, and transparent.

3. Develop funding mechanisms to support the development of open, interconnected and distributed scholarly publication infrastructures, and for their maintenance over the long term.

4. Consider how funding policies affect diversity and inclusivity of research on a global scale. In particular, funders should work to ensure that review boards, committees, panels, etc., are diverse - in terms of gender, geography, and career stage.

5. Work with the other actors in the scholarly communications ecosystem to ensure that the total costs of enabling research to be openly available to everyone, everywhere, without barrier or restriction, be also open and transparent.

4   Publishers and other scholarly communication service providers

As seen earlier, publishers (for profit and non-for profit, including institutional publishers and learned societies), are currently the major service providers for all key functions of scholarly publishing. Presently, they mainly serve researchers as well as universities and other research institutions, but they can serve all potential users of research findings if

publications are readily accessible and re-usable. The continuing digital revolution presents a number of challenges (and opportunities) for publishers, not least since it increasingly calls into question what scholarly 'publishing' means.

Various actors, not all traditional publishers, are already seeking to develop sets of services and tools across the entire research workflow. Services to alert potential users to the **registration** of many different kinds of content are becoming increasingly important. The processes associated with **certification** are becoming more open and transparent. They are becoming part of the conversations, discussions and debates characterizing the distributed production of knowledge and, as a consequence, they are being integrated in the public presentation of research results.[58] With regard to **dissemination**, enhanced discoverability will become more important. Presenting research findings with reliable signs of high standards will help navigate an increasingly complex documentary landscape. At the same time, requiring open access to research results pushes traditional publishers towards open access business models. Finally, keeping the record of the changing versions of content, rather than a single version of record, will also become increasingly important, as will their **preservation**.

The **evaluation** of researchers has long been associated with the rankings of journals, and it is sometimes presented as a fifth publishing function.[59] However, the link between journal rankings and evaluation of research has generated many downsides, discussed earlier in the report. The evaluation of research must focus on content, not on proxies such as journal titles. There is a broad consensus on the need for reform in this area, and progress is actually being achieved. When the evaluation function of journals becomes less important, the implications for research communication and therefore publishers will be profound.

Publishers and other service providers should:

1. Develop and publicly announce transition plans to move as soon as possible to comprehensive open access.[60]

2. Develop, use, and support interoperable tools (including open source software wherever possible) and services not only to facilitate access and reuse of scholarly outputs, but also to facilitate innovative interventions of new entrants.

3. Strive for balanced diversity (including, but not limited to, gender, geography and career stage) among authors, reviewers, and editors who work with publications.

4. Foster transparency and accountability in peer review, for example by publishing peer review reports and author responses alongside the published articles.

5. Make all publishing charges public (including special pricing and waivers), and provide *full* descriptions of services provided, in order to enable the development of a transparent and cost-effective marketplace designed to support the open communication and reuse of all scholarly contributions.

6. Experiment with new approaches to the evaluation and communication of research outputs, and share the outcomes so that a body of evidence can help to optimise future systems.

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[58] In this direction see the open letter by ASAPbio in early 2018 that has been signed by many publishers on the significance of publishing peer reviews https://asapbio.org/letter

[59] As noted in an earlier chapter, the recent "STM Report - An overview of scientific and scholarly publishing" in its fifth edition of October 2018, has introduced "navigation" as a fifth function of journals, p. 14.

[60] Springer Nature and Elsevier have differing views with respect to this recommendation, a result of extensive discussions in the expert group.

5   Practitioners, Educators, and other Social groups

The professionalisation of scientific research, and the increasing costs of access to the research literature have gradually contributed to separating the research communities from society at large. In fact, the rise of a "popularisation" profession can also be read as a symptom of the growing gap between researchers on the one hand, and the general population on the other hand. Separating research and research communities from the rest of society may open the door to various forms of alienation and even hostility to the knowledge enterprise in general. In reality, anyone, however removed from research, maintains some minimal degree of competence with regard to the present state of knowledge. This is also what the world brain means: it does not work on a two-tier basis separating the "knowers" from the "ignorant".

In our societies, production of, and access to, knowledge does not concern only researchers. As explained in the previous chapter, society at large, including actors with different motivations and needs (e.g. practitioners, educators, SMEs etc.) require, and should be entitled to access knowledge. Practitioners, educators and other societal groups willing to apply scientific knowledge to their needs should be able to access this knowledge in seamless and convenient ways. For this purpose, a comprehensive adoption of Open Access models (not just gratis, but libre in terms of sufficient reuse rights) is required to enable criticising relevant research results and build upon them. These actors can also contribute to the production of knowledge, and it has been demonstrated through specific cases that their contributions can make a significant difference[61].

What is broadly missing are the ways to help the demand organize itself so as to be expressed in a clear and audible way. Yet, doing so would do a great deal to help reduce the gap between research and the rest of society, and it would certainly enhance the diversity and richness of the knowledge enterprise. For example, having issues, problems, questions percolate upward toward funding agencies so as to make them more aware of some of the worries and questions emerging from the population at large, and having parts of the research budgets devoted to research programmes corresponding to these concerns, would mean directly involving the citizenry in research planning. But mechanisms have to be designed to provide new channels of communication between various segments of our societies which, presently, do not know how to converse with each other.

Here again, the metaphor of the world brain can support this line of thinking: the brain, while somewhat specialized in its functions, is also deeply incorporated in the body. Scholarly research, likewise, while sporting specialised functions and objectives, cannot work well if kept as a separate entity, and the situation grows worse if the principles of separation also incorporate principles of elitism. Approaching science as a social system, made up of scientists who are simultaneously members of societies and influenced by values, needs and expectations like any other human being, requires at times critical reassessments "from outside" to correct potential biases or hitherto overlooked aspects in scientific debates.

Practitioners, educators, and other societal groups should

1. Organize and advocate for free access to, and right to reuse of, publicly funded research results.

2. Reach out to funders, research institutions, and policy makers in order to develop new communication channels, new forms of co-creation and co-planning of research, and

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[61] For example in citizen-science driven astronomy project https://www.zooniverse.org/. See also Committee on Designing Citizen Science to Support Science Learning et al., *Learning Through Citizen Science: Enhancing Opportunities by Design*, ed. Rajul Pandya and Kenne Ann Dibner (Washington, D.C.: National Academies Press, 2018), https://doi.org/10.17226/25183.

new forms of funding in response to needs, concerns and issues emanating from the population at large.

3. Look for opportunities to engage with research topics / results that are of interest to societal groups and their communities.

4. Bring forward research topics/questions that are mis- or underrepresented (e.g. by contacting relevant researchers, attracting the attention of other actors in the science system, or mobilising action in organised interest groups).

CHAPTER 6: CONCLUDING REMARKS

Tasked with peering into the future, the Expert Group on the Future of Scholarly Communication and Publishing had to avoid making use of one technology – the crystal ball – because, like many other technologies, staring at it blinds rather than enlightens. Of course, technology will be an important part of the future of scholarly communication, but the decisive technological event has been the triggering of the transition to the digital context, and this started decades ago. The present period corresponds to a particular stage in the unfolding of the digital sphere with its cultures, economics and social dimensions. Some of the stages may perhaps be compared in scope to the invention of the rotary printing press within the print culture, but they remain a part of the unfolding digital culture. Techno-fiction was thus set aside and the Expert Group proceeded to look for continuities and forms of stability, in the midst of a rapidly shifting publishing landscape, and to pay attention to what should be avoided.

Continuities and forms of stability have been expressed in a set of four functions and ten principles which exist independently of technical progress. As to what to avoid, the Expert Group has identified a number of flaws and problems in the present system. These reflect either a poor integration of the possibilities offered by the digital sphere (affordances), or, more fundamentally, systemic obstacles to the optimal progress of scholarly publishing. At the same time, the scholarly publishing system displays two fundamental lines of force that can be used to build new perspectives on the scholarly communication and publishing landscape: the money flow and the compound nature of publishing.

The ways in which money flows in the scholarly communication system can appear hopelessly complex, but, in the last analysis, it rests on two major poles, both made of public and private entities. The first pole essentially corresponds to the funds coming from universities through their libraries. The role of public money in that group is generally dominant, particularly in Europe. Since the advent of APCs, funding agencies have also been drawn into the business of supplying funds to help their grantees publish in open access journals – a trend often justified by a requirement or a mandate for open access emanating from the same funding agencies. This, in turn has drawn the funding agencies into peering more deeply into the communication and publishing system, to the point of even becoming directly involved with it. Some of the private charities, such as the Wellcome Trust in the UK and the Bill and Melinda Gates Foundation in the USA have blazed some important trails in this regard, and continue to do so.

The second pole is made up of the service providers, a group presently dominated by publishers, but where new actors are now appearing even as new or improved services are invented or redesigned around digital technologies. An example of this is the growing importance of Google Scholar, a search engine that has emerged outside the publisher world. It has become indispensable to researchers. Service providers often sell their services to libraries and funding agencies, and this is the deeper reality of money flows behind the daunting complexities of fund-transfer channels.

Together, the two poles just identified reveal a global mechanism whereby a mix of organisations, often dominated by public institutions in the case of Europe and many other parts of the world, provide the financial underpinnings for a number of publishing and communication operations. Most of these operations are dominated by for-profit corporations and a few non-profit societies (for example the American Chemical Society).

The second pole also shows that, in the digital context, the publishing functions no longer belong exclusively to a unique category of organisations – namely the publishers. Through their economic behaviour – for example the types of firms they acquire – publishers themselves actually show that they behave as an aggregate of functions. Publishing, therefore, is increasingly viewed as a composite activity that can be re-organized across many different types of actors. Predictably, a number of new actors are beginning to test their ability to take on some or all of these functions, thus opening the possibility of a

vastly re-structured publishing world. How these functions will ultimately be distributed across what types of organisations is one central question that needs to be monitored with care. The manuscript world was organized around a number of carefully designed functions, many of them linked to the scriptoria; the print era reorganized some of the functions and added new ones to form the modern publisher, and scriptoria vanished; nowadays, the digital sphere is beginning to show its own effects in this regard. We are watching as these new kinds of actors strive to take shape, but traditional publishers are clearly in the crosshairs of digitisation.

In the latter half of the 20th century, the publishing functions already identified (registration, certification, dissemination and preservation) saw the rise of a fifth important function: evaluation. As pointed out in the report, this last function has been increasingly contested: does evaluating research through its publishing venues make sense? Or, if it makes sense, what is the meaning of such an operation?

The keystone of this evaluation function, the JIF, was originally designed to provide a metric for journals competing with each other. From there, it was a small (but unwarranted) step to the evaluation of individual research pieces, to the evaluation of individual researchers, to institutions, and even to whole countries. As a result, evaluation processes, all based wholly or in part on the JIF, were eventually erected in a structure not unlike that of Russian nesting dolls. The consequence was the creation of a system such that the decision to reform one of its parts could affect rankings at another level. Managerial and other forms of caution thus dictated staying in line, and the system thus developed has displayed considerable resilience.

With the JIF firmly in place, publishers adapted their tactics and strategies to its presence. Raising the impact factor of their journals has been a constant preoccupation among publishers for a long time. Promoting the JIF of journals is a common marketing argument. Some journals and some publishers have even been caught actively gaming the JIF rules.

Given the great variety of actors working in the scholarly communication and publishing landscape, it would be a very useful exercise to assess with precision what, in each case, would be the consequences of living without the JIF. What other modes of evaluation would be more appropriate for each perspective? Outside the general public, only funding agencies have the luxury of standing somewhat beyond the reach of the JIF: the reason is that they rank other actors with it, but they are not ranked[62]. And they have a fair degree of control over a large fraction of the funds on which research rests. This should allow the funding agencies to imagine taking a leadership role in any effort to improve the scholarly communication and publishing system. And some have already started to do just that, particularly private charities such as the Wellcome Trust and the Bill and Melinda Gates Foundations. Other actors such as individual researchers, research institutions, and even countries have some means to be helpful, but the risks to their own standing in a competitive field constructed as it is at present are simply too high to be undertaken lightly.

The best way to make the scholarly communication and publishing system evolve in a way satisfying the research-centred perspective favoured in the report is to maximise cooperation and collaboration among the actors willing to act in such a direction. Funding agencies, therefore, will see their influence grow in proportion to their ability to rally most or even all of the actors involved in the scholarly communication and publishing ecosystem. Their basic role may rest on the simple idea that the evaluation of research should take place not only according to the basic tenets of the scientific method – that is obvious –, but also according to the fit between the published works and the parameters of the research programme as enunciated by the funding agency. Presently, publishing requires serving many determinants at once: a team or laboratory's research trajectory, a funding

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[62] However, as part of ministries that belong to governments worried about the rankings of the whole country, or how the country shows up in the world, public funding agencies may not enjoy total freedom from the JIF. This may explain the leading role taken by private charities. The EC, as a funding agency, lies somewhere between private charities and national public bodies: ranking Europe requires identifying credible contenders. Which ones?

agency's research programme, and, for a journal editor, a ranking-conscious strategy in selecting submitted articles. Reducing this conundrum by at least one element – the ranking concerns of journals in selecting articles – increases the probability that the published work will fit the funder's research programme more closely.

The role of funding agencies can go further still: they can actually work with scholarly societies, with libraries and the research institutions they serve, and with publishers willing to provide forms of scholarly publishing that clearly separate the economic value of publishing from the intellectual value of research. In so doing, they can restore the idea that research can be seriously evaluated only if the content of the research is studied by the specialists in the field. In the same line of argument, funders should find it easy to collaborate with research institutions as the criteria for evaluating researchers for career advancement purposes overlap with the criteria needed to evaluate researchers for research worthiness on a specific project.

While funding agencies benefit from an ability to act that other actors, with the possible exception of some powerful publishers, do not enjoy, their initiatives will not be effective if researchers, learned societies and research institutions do not face up to their own responsibilities. Instead of outsourcing tasks almost by default, and be caught in the short-sighted vision of systematic competition, research institutions, researchers and their learned societies should aim at networking around coherent communication and publishing objectives. In short, they should make it their collective responsibility to take back control over their communication needs and means rather than adopt the attitude of passive consumer of services-for-sale. In the case of scholarly societies, particularly large ones, the objective of "taking back control" would mean examining whether the present system of competition for journal market shares, despite its capacity to generate high "surpluses", is entirely congruent with their most fundamental mission, which is to serve scholarly communities.

Funders will also have to think about the ways in which they can offer examples of publishing sites that operate according to the principles laid out here. Doing so will mean establishing models designed to influence the ways in which scholarly publishing may evolve.

The funding agencies have yet another role to play: either through requirements to their grantees, or though providing their own publishing models, they can affect a number of technical issues, such as openness, interoperability, and metadata. They can peg down and clarify the ways in which terms such as open access are to be understood and practised. They can give substance to expressions such as "open science", for example in making clearer how knowledge should be accessible, circulated, and both influenced and used by the general population in its various, non-scholarly, roles. In short, funding agencies can work out a series of criteria that define how high the scholarship bar is to be raised, and to what effect.

As stated already, the leadership taken by the funding agencies will work only if it rallies most, if not all, of the actors of the scholarly communication ecosystem. Given the possibility of changing the criteria used to evaluate research, collaborating with the researchers, the universities and the research centres should prove fairly straightforward. Working with various strands of the general public should include imagining and creating communication channels allowing for a real voice to influence research priorities and orientations. With publishers, it is clear that cooperation is also needed, although there are likely to be further challenges to existing business models. Underpinning these collaborations, it is to be hoped that all actors will view the perspective of moving into truly innovative areas as very much in line with the most fundamental purpose of scholarly communication.

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The report proposes a vision for the future of scholarly communication; it examines the current system -with its strengths and weaknesses- and its main actors. It considers the roles of researchers, research institutions, funders and policymakers, publishers and other service providers, as well as citizens and puts forward recommendations addressed to each of them. The report places researchers and their needs at the centre of the scholarly communication of the future, and considers knowledge and understanding created by researchers as public goods. Current developments, enabled primarily by technology, have resulted into a broadening of types of actors involved in scholarly communication and in some cases the disaggregation of the traditional roles in the system. The report views research evaluation as a keystone for scholarly communication, affecting all actors. Researchers, communities and all organisations, in particular funders, have the possibility of improving the current scholarly communication and publishing system: they should start by bringing changes to the research evaluation system. Collaboration between actors is essential for positive change and to enable innovation in the scholarly communication and publishing system in the future.

Studies and reports