Priorities for Reform of Scientific Publishing

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For discussion

In response to concerns amongst its Members about the extent to which current systems of scientific publishing serve the international scientific enterprise, the International Science Council (ISC) has published two reports [1, 2] that analyse the issue and commits itself to work for necessary change. An ISC Steering Group has been set up to propose actions. It presents the following to the 2021 General Assembly of the ISC as proposals for action and as a basis for engagement with Members in seeking reform. The proposals are bold and ambitious, and their implementation will challenge aspects of the culture and practice of science that have developed in recent decades. An ad hoc group of publishers is being set up to provide expert feedback on the practicality and economic feasibility of recommendations for alternative business models, licenses, publishing infrastructures, and governance practices.

You are invited to read the paper as preparation for the session that will take place on 14 October at 12:55 pm UTC, at which the proposals for action will be discussed. A resolution to support the principles set out in the ISC report [1] and to work together to achieve necessary reforms will be placed before members for their endorsement.

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Preface

In response to concerns amongst its Members about the extent to which current systems of scientific[1] publishing serve the international scientific enterprise, the International Science Council (ISC) has published two reports [1, 2] that analyse the issue and commits itself to work for necessary change. An ISC Steering Group has been set up to propose actions. It presents the following to the 2021 General Assembly of ISC as proposals for action and as a basis for engagement with Members in seeking reform. The proposals are bold and ambitious and their implementation will challenge aspects of the culture and practice of science that have developed in recent decades.

1. Roles and responsibilities for scientific publishing

Publishing is fundamental to the scientific enterprise. It plays two interrelated roles:

- it makes knowledge claims, and the evidence on which they may be based, openly available to be tested against reality and logic through the scrutiny of peers, thereby forming the basis of 'scientific self-correction';
- it is the principal route by which the results of scientific inquiry are introduced into the public domain for all who may wish or need to access them.

The 'record of science', the published record of scientific knowledge and understanding from the earliest days of scientific inquiry to the present, is contained in books, monographs, scientific journals, preprints and the 'grey' literatures published in governmental and institutional reports, whether in print or digital formats, or as digital objects. It is continually refreshed, renewed, re-evaluated or rejected across the disciplines of science by new experiments, new observations and new theoretical insights.

The vision of the International Science Council (ISC) is of science as a global public good [3], which requires that scientific publishing satisfies two fundamental scientific responsibilities:

- that it is globally inclusive, with none left behind, a voice for all, and sensitive to diverse perspectives;
- that ideas, evidence and data circulate freely, quickly and efficiently, are disseminated widely and deeply, and are openly available for sceptical scrutiny, application and re-use.

The ISC believes that it is a responsibility of scientists and their institutions to adhere to these responsibilities [3]. The delivery of these roles and responsibilities will also determine the success or otherwise of current efforts to internationalize open science [4], all of which are fundamentally dependent upon effective exploitation of digital technologies in both communicating and creating new knowledge. Much current scientific publication, though utilizing digital means, is still based on a print and paper model, which, though it can be lucrative to publishers, fails to optimally exploit the technological opportunity.

[1] The words **scientific** and **science** are used to refer to the systematic organization of knowledge that can be rationally explained and reliably applied. It is inclusive of the natural (including physical, mathematical and life) science and social (including behavioural and economic) science domains, which represent the ISC's primary focus, as well as the humanities, medical, health, computer and engineering sciences. It is recognized that there is no single word or phrase in English (though there are in other languages) that adequately describes this knowledge community. It is hoped that this shorthand will be accepted in the sense intended.

2. Essential principles for scientific publishing

The ISC report *Opening the Record of Science* [1] sets out a series of principles for scientific publishing that are designed to ensure that these roles and requirements are well served. The principles are summarized below in italics, followed by comments, in plain type, that identify serious shortfalls:

2.1 **There should be universal open access to the record of science, both for authors and readers, with no barriers to participation, in particular those based on ability to pay, institutional privilege, language or geography.** Excessive prices put much of the record of science beyond the reach of many who would wish to access it. Many in low- and middle-income countries are excluded, resulting in a fracturing of the international scientific community.

2.2 **Scientific publications should carry open licences that permit reuse and text and data mining.** Too much of the record of science is inaccessible for reuse and the application of modern methods of knowledge discovery because of high paywalls and restrictive licences. Some publishers seek to monopolize metadata in monetizing and controlling access to knowledge.

2.3 **Rigorous, timely and ongoing peer review must continue to play a key role in creating and maintaining the public record of science.** Conventional peer review is foundering under pressure. It is often slow, ineffectual and inefficient. Reforms that better respond to needs of science and utilize the resources of its institutions are urgently needed.

2.4 **The data and observations on which a published truth claim is based should be concurrently accessible to scrutiny and supported by necessary metadata.** Data are in principle as important an output of science as text articles, but in the absence of formal norms, too much is lost. They should be concurrently accessible under FAIR (Findable–Accessible–Interoperable–Reusable) principles, and with routes to access where general access needs to be restricted because of considerations of safety, security or privacy.

2.5 **The record of science should be maintained in such a way as to ensure open access by future generations.** With the demise of the physical 'library of record' it is vital to develop digital means of ensuring enduring access to the global record of science and the means of identifying and accessing its content.

2.6 **Publication traditions and bibliodiversity of different disciplines and regions should be respected, whilst recognizing the need for communication and interoperability in the shared enterprise of knowledge.** Inter-operability between different disciplines of the scholarly record is poor and relevant technologies are under-utilized, including those that could support multi-lingual communication.

2.7 **Publication systems should be designed so as to continually adapt to new opportunities for beneficial change rather than embedding inflexible systems that inhibit change.** Outmoded forms of publication derived from the print and paper era dominate much current publishing. They should be replaced by more efficient and flexible forms that exploit the developing potentials of digital technologies.

2.8 **Governance of the processes of dissemination of scientific knowledge should be accountable to the scientific community.** Access to scientific knowledge, and strategic knowledge about science is increasingly monopolized by major commercial publishers/technology companies whose principal responsibility is to their investors rather than to science.

It is recognized that some of these issues are highly complex, as analysed in the ISC's recent report [1], but that strong statement of first order principles is a necessary guide to action in in the pursuit of solutions.

3. Promoting change

3.1 Developing a consensus

The above conclusions underline the urgent need for radical reform of many aspects of current scientific publishing. The ISC is working to create a consensus for change with other key stakeholders in the scientific enterprise. It is working to do this with its membership, as representative of the international scientific community; it is particularly seeking to work with national and international research funding bodies, universities (and their international representative bodies such as the Global Research Council and the International Association of Universities) and institutes, learned society publishers, open access publishers, and open science bodies; and will seek to coordinate activities with UNESCO and other representative bodies of international science such as the Global Young Academy (GYA), the Inter-Academy Partnership (IAP) and The World Academy of Sciences (TWAS). It will reach out to civic society on the basis that a project that seeks to serve the global public good must be a public enterprise.

3.2 Initial priorities

Section 2 identifies major shortcomings in the operation of global publishing systems, implying the need for an ambitious agenda for action. In view of current trends in scientific publishing, we identify two immediate priorities: 2.1 – affordable and equitable universal open access (OA) for readers and authors; and 2.8 – the issue of governance, that processes that are fundamental to dissemination of scientific knowledge should be accountable to the scientific community. These priorities will however be approached in ways that are consistent with making progress on the other priorities in Section 2.

The experience of the COVID-19 pandemic has been both informative and encouraging about prospects of reform in the direction of open science. Although the benefits of open science were previously largely matters of conjecture, the response to the pandemic was a successful example of open science in action, whilst also exposing some of the processes that inhibit the effectiveness of science in contributing to the global public good. Scientists from many disciplines and countries creatively deployed and applied their knowledge, produced databases and websites, short-circuited the cumbersome processes of conventional publication through the use of preprints, and shared data and ideas with unprecedented openness in ways that set aside conventional constraints and across the public-private interface. The Director of the US National Institute of Health commented: 'we have never seen anything like this' – 'the phenomenal effort will change science – and scientists – forever' [6]. The experience should be used as a springboard from which to create a new normal that advances open science by promoting the principles in Section 2.

3.3 Approaches to action

The technologies now available to publishing could radically improve performance in four fundamentals: processes of affordable access by authors and readers, processes of effective scrutiny and review, processes of platform-agnostic discovery and processes for programmatic access to publications and data to enable AI-driven discovery. Possible approaches include:

a) The experience of the COVID-19 pandemic has demonstrated the acceptability and utility of preprints as means of rapid, open communication of ideas within and beyond the scientific community, whilst also exposing bad practice, for example in failing to reveal when a preprint is unreviewed. Most national and institutional open access policies prioritize or support institutional repositories as OA venues, not subject repositories. However, broadly based repositories such as arXiv are cost-effective means of speeding up discovery science. If added to by a rights retention policy allowing for immediate deposition of the 'author accepted manuscript' as part of the record of version, we will then, effectively, have full green open access.

b) A validation layer, that currently journal editors provide, is needed in repositories, preprints and other community-led publishing platforms in order to create more efficient and reliable forms of peer review to supersede a traditional journal-organized system that is overburdened. Peer review could thereby be more effectively embedded as a science community responsibility and recognized as such. A reformed peer review system could, for example, attach badges of quality and significance to digital items, thereby making the use of Journal Impact Factor (JIF), which serves to drive up prices is and widely criticized by over 20,000 signatories to the San Francisco Declaration (sfdora.org), redundant as a proxy for quality. Overlay journals can also offer a route to peer review, as do novel forms such as PeerCommunityIn.

c) Such changes would mean a shift away from the concept of the version of record and towards a record of versions. They would require platform-agnostic search and discovery tools to locate relevant research outputs (for example ADS, INSPIRE and PMC). They need to be discipline based and have knowledge of disciplinary terminology and semantics (e.g. the NASA funded Astrophysical Data System has revolutionized literature searches in Astronomy, allowing full-text searches of the entire corpus of astronomy, including preprints on arXiv, conference proceedings and observing proposals). By putting all publication venues, including preprint archives and institutional repositories, on the same footing, it removes some of the pressure to publish in expensive 'prestige' journals.

d) Data about science, acquired by publishers as part of the publication process, are important inputs to data management and research information systems covering institutes, projects, researchers, assessment resources and the strategic management of universities and institutes. It is important to encourage development of scholar-led data acquisition and management systems and governance procedures that are accountable to the scientific community and its institutions (see separate governance discussion). A 'Digital Markets Unit' designed to identify and avoid monopolistic practices could be a powerful adjunct to such developments.

e) Systems are required for long-term curation of the record of science that are individually or collectively in federation, and comprehensive in their disciplinary and geographic cover (potentially building on examples such as CLOCKSS). They should support interoperability and ensure discoverability, access and use of content by multiple publishing platforms and infrastructures. A federated, global, modern equivalent of the copyright-deposit library system adopted in most countries (but now entirely inadequate for modern digital media) is required. This could also be a means of curating and conserving not only traditional articles but a wider range of digital research products including other publications, data, software, protocols, even hardware designs.

f) Current systems lack incentives or funding to adequately curate the data *of* science. The ISC Report advocates citable data publication as a source of incentive. Means by which this might be done have been developed by data bodies (e.g. RDA, CODATA, WDS), but have not been taken up by funders, universities, researchers or by indexing bodies. These, and processes by which funders of research also fund the process of FAIR curation, should be part of our approach to stakeholders.

The ISC approach will be to promote normalization of recent innovations rather than direct reform of the dominant commercial, journal-based publishing model. This would include normalizing the roles of preprints, preprint servers, overlay review systems, open licensing, data publication, 'Diamond' models of publication, etc. If the scientific community, as consumers of publishing services, can act in concert in exercising choice, reform will have been achieved.

The processes by which scientists and science are evaluated are major determinant of institutional and individual behaviour. For example, evaluations that utilize bibliometric concepts such as the 'high impact journal' support publishers' business models in ways that undermine our first principle of affordability and inclusion (2.1), whilst being weak and highly indirect indices of scientific quality. We anticipate working closely with a joint ISC-IAP-GYA working group that is currently scoping this issue.

4. Value propositions to stakeholders

Achieving radical change in publication systems will require collaboration from ISC Members in addressing key stakeholder groups:

- the funders, both public and private, that fund science and ultimately sustain the science publication system;
- the institutions that support the scientific effort and its infrastructures;
- the researchers whose choices of publication outlets determine publishing business models.

There is the greatest prospect of achieving mutual collaboration between these stakeholders in accepting and driving change when their individual needs and motivations are served by change, and where all are inspired by a **common purpose** and a **value proposition** that speaks to the motivations of all. The propositions for the above three groups are:

Funders of science, whether governments, their science funding agencies or private foundations. They invest in scientists and their work in order to maximize the return of scientific knowledge that, in a variety of ways, is deemed to serve the public good. This priority would be better served by a system that speeds up the circulation of scientific ideas and information, makes access easier for both readers and authors, reduces unit costs, provides a clearer relationship between supply and demand, with greater transparency and locates governance within the science system. An open research environment where persistent funding identifiers are part of the metadata would allow much improved monitoring of outputs and enhanced visibility of funders' programmes.

Universities and institutes that employ scientists and provide supporting infrastructures. Their concern to advance the frontiers of knowledge is strongly conditioned by an imperative to enhance their reputation and their income from research. Their priorities would be better served by a system that increases affordability of access, a growing challenge for universities across the world, addresses the deep inequalities between systems of higher education and between universities, and improves the engagement space between universities and society at large. A greater role in governance of scientific publication would provide universities with more direct control over key business decisions such as academic promotion or research strategy by not relying on expensive, opaque commercial analytics. This would also permit them to be more discriminating in their use of metrics in ways that serve their individual and community priorities.

Researchers are inspired by the search for new knowledge, although in ways that are strongly conditioned by concern for their careers and the evaluative, bibliometric indices that are typically, and increasingly, central to career evaluations. Improved affordability would particularly benefit researchers in relatively poorly funded science systems and institutions. Increased accountability of scientific publishing and its indicators to the scientific community would enable publishing to be more creative in exploiting technology in developing new modes of communication and use, whilst permitting their universities to more creative in evaluating the work of their scientists.

There are also value propositions to be developed and directed towards small and medium size enterprises (SMEs) that cannot afford to run research units with large library budgets, and to community groups, both of which are currently excluded from accessing much potentially relevant research from which they could benefit. More broadly still, there is the issue of more effective engagement with civic society and citizens. In an age where difficult political decisions are increasingly informed by research findings, and where public support is vital for policy implementation, finding effective ways to make research outputs accessible to a wider community should be a priority. Such outcomes can be more sensitively, transparently and trustworthily delivered where process governance lies in the hands of the science community rather than in a private enterprise whose principal responsibility is to its shareholders rather than to the public good.

There are several other complexities that need to be addressed in any process of reform. For example, many learned societies publish their own peer-reviewed journals and are well placed to play a leading role in change, particularly in maintaining high standards and through their access to large cohorts of expert reviewers. However, the challenge of providing affordable open access to both readers and authors is a problematic financial issue for them and one that needs attention.

5. Governance

A major impact of digitalization has been to fuel the growth of so-called tech giants that exercise product monopoly, giving dominant players exorbitant market power across all sectors. Commercial publishers are currently transforming themselves into technology platforms designed to dominate and control awareness of new science and access to it, whilst at the same time monetizing the data about science that they collect from their publishing activities as a basis for assessment of science and scientists, and the management of and strategies for science.

The ecology of most national science systems has tended to one where the perspectives of three critical players have been balanced: government, arm's length funding agencies, and, largely, universities (with publicly funded institutes playing a more or less significant role). This ecology has determined the governance of a largely public-funded resource based on a shared intent to work for the public good. Interventions at scale in that ecology, and from a position of control, by major commercial platforms threaten to privatize key aspects of the knowledge society, undermining the potential of open science to deliver for the global public good.

It is the view of the ISC that the governance of the publishing process, that forms the point of entry for the commercial sector, should be accountable to the scientific community and its institutions. In a similar vein, UNESCO has recently called [4] for the monitoring of open science to be explicitly kept under public oversight – to include the scientific community, and whenever possible, to be supported by open non-proprietary and transparent infrastructures. UNESCO further cautioned that while this monitoring aspect could include representatives from the private sector, it should not be left to them to control.

5.1 A possible governance model

To ensure that this critical function is designed and sustained by the community it is intended to serve, it is suggested that the following steps be considered:

a) Adopt a governance model in which the global research community creates a new global facility/service that operates under the auspices of key international scientific organizations as custodians of the international scientific interest with a mandate to secure open access to the record of science and its independent, shared governance and resourcing.

b) Consider an implementation of this model that achieves compliance through a minimal central governing body, adherence to agreed open science principles, diversified sources of funding, and promotion of decentralized infrastructures that interoperate through adherence to open standards.

c) Consider how a reformed system could not only be sensitive to different disciplinary traditions and needs but also to varying regional and national priorities and ways of working. Major international representative bodies of science tend to have such disciplinary and regional/national representation in ways that already recognize this variability, and which could readily be adapted to support federated governance mechanisms.

d) Enhance this proposal with concrete examples of new models and infrastructures that can flourish under the envisioned governance conditions.

e) Explicitly adhere to the UNESCO open science core values and guiding principles, namely: quality and integrity, collective benefit, equity and fairness, diversity and inclusiveness, transparency-scrutiny-critique-reproducibility, equality of opportunity, responsibility respect and accountability, collaboration-participation-inclusion, flexibility, and sustainability.

f) Model a proposal based on what can be learned from other consortium-based efforts that have succeeded or that have promising new structures (such as The World Wide Web Consortium (W3C), Internet2, DuraSpace/LYRASIS, Aligning Science Across Parkinson's (ASAP), the Confederation of Open Access Repositories (COAR)), while also intentionally informing the proposed structure with the lessons learned by others that have not.

g) Foreground the role and responsibilities of academic institutions as sources of distributed innovation and investment, on a par with the role that funders have already begun to play in supporting open science and re-designing academic incentives.

5.2 Community-owned infrastructures

Global consensus is mounting in support of the imperative to create an open record of science, and to ensure equitable access in contributing to as well as benefiting from the published record. The current spotlight is on the critical need to move away from reliance on commercially controlled publishing infrastructures and practices, which reinforce the dominance of players whose interest and values are not always aligned with those of the research and higher education communities, and to invest in and develop systems that are resistant to capture and control by any single entity – commercial or non-commercial.

Experience has shown that establishing a robust array of distributed, community-controlled infrastructures (i.e., those that are either owned by the communities they serve or have functioning governance structures representing the community's interests) has the potential to play a transformative role in establishing and sustaining a more equitable research ecosystem.

The research ecosystem comprises a diverse set of global stakeholders, and community-controlled infrastructure solutions can be configured and adapted to meet local and regional needs. For example, intellectual property management infrastructures such as Creative Commons licenses provide a flexible set of modular agreements that can be readily translated into appropriate languages and configured to align with knowledge sharing terms and conditions that best reflect local priorities and preferences.

Community-run persistent identifier solutions such as DataCite, Crossref, and ORCID provide an interlinking and metadata backbone to the scientific record and can also play important roles in ensuring appropriate credit is assigned to those who contribute to it. The FAIR principles for scientific data management and stewardship guide the implementation of community-led networks and services for storing and sharing scientific data. Institutional repository platforms like DSpace and Fedora, and publishing solutions built on open-source software such as Open Journal Systems and PubPub, support community-led publishing efforts and the inclusion of the widest possible range of voices. Mind the Gap is a recent landscape analysis of open-source publishing tools and platforms that provides additional examples of open publishing infrastructures.

The essential requirements and capabilities for such alternative publishing infrastructures are summarized in Section 3.3 of this document. They include open standards, protocols, and processes for interoperability and information flow among component solutions. The ISC and its Steering Group on Scientific Publishing, in partnership with like-minded policy initiatives around the world, commit to developing governance and sustainability frameworks for infrastructure reform.

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