Comments on 'Science 2.0'

SCIENCE EUROPE
Shaping the future of research

Response to the European Commission Consultation on 'Science in Transition'

Executive Summary

Researchers have embraced Information and Communication Technologies (ICT) as a tool to share and exploit scientific knowledge in novel ways and to strengthen scientific relations within increasingly international research communities. In this document, 'Science 2.0' refers to these researcher-driven practices.

It may be tempting to treat Science 2.0 as a political programme for a new kind of science; however, it is not. Science 2.0 practices are developed bottom-up within research communities in answer to diverse needs in varied scientific communities with different scientific practices and cultural backgrounds. Policy makers should ask how they can support these developments by removing obstacles to the creativity of researchers and by providing targeted support, backed by evidence of their contribution to excellence.

The use of ICT-enabled sharing and community practices in research is not new. Policy makers have already responded by developing policies in specific areas. The Science Europe Roadmap defines priority action in a number of areas related to Science 2.0, including Open Access to publications and to data, e-infrastructures and science in society. Science Europe welcomes this debate as an opportunity for policy makers to explore the synergies between such actions and between organisations.

Main Recommendations

- Recognise that **research communities are developing Science 2.0 practices organically** and that they are best placed to explore which of these contribute to the advancement of their discipline.
- Guide any policy interventions in Science 2.0 practices with **evidence of their effect on the excellence, impact and efficiency of the resulting research**. The implementation of the recommendations below should be underpinned by evidence.
- Support a **researcher-driven uptake of Science 2.0 practices** by focusing policy interventions on **creating an enabling environment**—that is removing administrative barriers and alleviating negative incentives.
- As a first, **short-term action** for research organisations: identify and implement adaptations to their own, existing policies that will **remove barriers** to Science 2.0 practices in Open Access, infrastructures, integrity, peer review, and public outreach.
- Seek evidence to identify which Science 2.0 practices have reached a **level of maturity within a community,** such that their further development **requires policy backing**.
- As a **medium-term** policy process:
  - — Nurture the **capabilities and infrastructures for data stewardship and data-driven research** ('big data ecosystem'), as they are crucial to obtaining the benefits of a more open research system.
  - — **Build on Science 2.0 practices to strengthen desirable policy goals** in interdisciplinary research, knowledge and technology transfer.
- Recognise that **the impact of Science 2.0 is systemic** and that developing an enabling environment should be a common endeavour by **all research policy actors**.
- Be prepared to engage in long-term exchanges with research stakeholders to **build common understanding** about the role of ICT in the research system. Seek evidence from research to inform this process.
- Engage with **ERA stakeholders** on how Science 2.0 practices and thinking can strengthen a European research system that is **excellence-focused yet internally diverse**:
  - — Explore how Science 2.0 can be leveraged to **revitalise peer review**, making it more streamlined, transparent and supportive of the rich collaboration patterns in Europe.
  - — Explore how **Science 2.0 can contribute positively to research administration** inspired by, or tying into, Science 2.0 practices.

Science Europe
Rue de la Science 14
B-1000 Brussels

+32 2 22 60 300
office@scienceeurope.org
http://www.scienceeurope.org/

1 Science 2.0

Science Europe thanks the European Commission for launching a debate on Science 2.0 with this consultation.

Defining Science 2.0

The definition of the concepts 'Science 2.0' and 'Science in Transition' is a specific challenge in this debate. In the absence of a clear definition, they imply a transition that would change the essence of science more fundamentally than has happened before. It is obvious that a more nuanced definition is needed, as well as a more appropriate name. Agreeing on a definition is essential to the future debate on Science 2.0 and should involve all relevant stakeholders. Science Europe does not, therefore, propose a definition in this document, although the assumption is made that a definition would include at least the following aspects:

- 'Science 2.0' considers the **impact of digital/information technologies** on research practices;
- 'Science 2.0' explores synergies between changing research practices and the **effect on the research system as a whole**; and
- 'Science 2.0' is grounded in a certain vision of science as a **community practice**, founded on the open sharing and **incremental exploitation of ideas and data**.

The Debate

The uptake of practices related to Science 2.0 has been occurring for decades and has been largely driven by researchers. Nevertheless, the present discussion on the implication of these practices is timely in that it links with ongoing policy debates. In November 2013, Science Europe Member Organisations adopted the Science Europe Roadmap[1], which sets out their shared vision for European research and identifies a number of priority areas where they will take collective action towards achieving this vision. A number of these areas directly reflect elements of Science 2.0, for example access to research data, Open Access to publications, and research infrastructures. Science Europe welcomes the European Commission's open consultation as a clear indication of the recognition that the debate on Science 2.0 practices concerns all research actors, and hopes that this debate between European and national research policy stakeholders will continue, including in the context of the European Research Area (ERA).

1.1 Recognising the Issue and its Drivers

It is useful to recognise that Science 2.0 is essentially as a series of related practices, rather than a single, coherent model. These respond to the practical needs encountered by researchers in the accomplishment of their scientific activities. Below are examples of such practices that can be observed today.

- Publications under Open Access rules (fully open: PLoS, Frontiers; optionally open: Springer, Oxford University Press);
- Community discussions and comments on preprints[2] (hosted for example on.: arXiv, PeerJ preprints);
- Increased sharing of intermediary research results (open notebook research; blogs);
- Increased sharing of research data and software (Open Source: SourceForge, GitHub; Open Access data: Figshare, NIH-supported databases, European Nucleotide Archive);
- Use of text and data mining techniques to study previous research results;
- Research-oriented social networks (ResearchGate, Mendeley);
- Virtual collaboration (Open Science Framework, virtual infrastructures); and
- Seeing the public as a resource/partner[3] (Zooniverse, citizen science, care.data);

Information technologies have enabled the uptake of these practices, and the impact of the information technology industry must therefore be taken into account[4].

---

[1] The Science Europe Roadmap can be downloaded on the Science Europe Website: www.scienceeurope.org

[2] Trackbacks and explicit versioning are arXiv features supporting community engagement. For a discussion on community reaction to preprints, see: X Shuai, A Pepe, J Bollen: 'How the Scientific Community Reacts to Newly Submitted Preprints: Articles Downloads, Twitter Mentions and Citations'; PLoS ONE 7(11), November 2012.

[3] Promoting citizen science can however become a threat in areas that may lead to the dissemination of dual-use capabilities—e.g. bio-hacking of pathogens, computer hacking—or that are ethically fraught—e.g. do-it-yourself genetic tests.

[4] A number of companies provide services marketed at researchers. For example: Search providers (Google, Microsoft), IBM (big data services), or ResearchGate (research-oriented social network).

However, the role of technology and industry should not be overemphasised. **Science 2.0 practices are essentially driven by researchers themselves**. Some have a long history (for example, arXiv was started in 1991), while others are still being explored. In general, they respond to:

1. A strongly-held belief in the value of free circulation (and criticism) of ideas and the existence of communities of ideas that transcend institutional and hierarchical structures.
2. A re-appreciation of the role of data by researchers. Data is increasingly treated as the raw material of research rather than purely a means to confirm hypotheses.

Although Science 2.0 is not necessarily a coherent model to describe a new form of research system, it is likely that the continuing uptake of diverse Science 2.0 practices, their mutually-reinforcing effect and the underlying technological, scientific and social trends, will have a profound impact on research. As a consequence, all research stakeholders are involved: researchers, universities, research performing organisations, research funding organisations, governments and civil society, scientific publishers, and private research organisations.

At the core of these changes, however, individual researchers and research communities should be able to explore which Science 2.0 practices ultimately allow them to improve the excellence, impact and efficiency of the research that they conduct. This is also an opportunity for the research community to demonstrate a capacity to self-organise using Science 2.0 practices, allowing an evolution towards a more bottom-up, flexible research system. **Therefore, Science Europe strongly supports a researcher-driven development of Science 2.0 practices**.

1.2 Targeting Policies

Although emphasis must be on the role of researchers in driving the development of Science 2.0, it is important to accompany it with appropriate policy measures.

In general, policies should be focused on ensuring that the research environment does not repress the organic uptake of Science 2.0 practices. Science 2.0 practices, where researchers are not inhibited by negative incentives or administrative constrains, should be allowed to develop within the existing research framework. This includes citizen science, which researchers are exploring by relying on easily-accessible platforms like Zooniverse, and existing funding.

Where existing policies prevent Science 2.0 practices, these should be assessed and amended by the organisations concerned. Some specific instances are discussed in section 3, but the importance of grounding any policy change in evidence is emphasised in section 2.

Research communities may be unable to take up all Science 2.0 practices bottom-up without policy support: for example, to move to an Open Access model for publication or to obtain funding for data sharing. Section 4 contains discussion of specific policy areas where concerted policy interventions may be considered, insofar as a positive effect on research excellence can be demonstrated. Evaluation of Science 2.0 policies creates specific challenges that are discussed in section 2.

Policy makers should guarantee that Science 2.0 practices are ‘diversity-friendly’, and do not disadvantage researchers on the basis of gender, social background, ethnic origin and so on.

The Science 2.0 debate is an opportunity for all actors in the European research system to consider their long-term role in an evolving research system. Information technology and related societal changes could disrupt, or may be used to strengthen, the services offered to the research community. Some consideration is given to these questions in section 5.

1.3 Taking into Account the Diversity of Disciplines

It is important to emphasise that ‘Science 2.0 practices’ must not be understood as generic, but rather in the context of diverse research communities rooted in different disciplines and with diverse practices and cultures. Assuming a homogenous landscape would lead to a misunderstanding of the benefits and pitfalls of Science 2.0 and may overlook the fact that Science 2.0-like practices are already strongly embedded in some research communities[5]. It may assume that there are similar opportunities and costs in other communities, over-

[5] One can give as examples how drafts are being shared and reworked on arXiv in theoretical physics and mathematics, the embrace of Open Source in computer science, or RePec, a collaborative, voluntary, decentralised effort to disseminate papers in economic research.

estimating their benefits when applied to other disciplines or describing communities who do not embrace some Science 2.0 practices as 'lagging behind' or 'conservative'.

Only a bottom-up approach can ensure that the diverse needs and requirements of communities and disciplines are met when engaging in Science 2.0 practices. Once again, this does not preclude targeted policies, for example to promote cross-community collaboration focused on developing or sharing Science 2.0 best practices.

2 Evaluation of Policies Supporting Science 2.0

To successfully implement policies supporting Science 2.0 practices, these must be driven by evidence. Policy recommendations made in this document should not be adopted without simultaneously considering the evaluation practices that might underpin their implementation or, indeed, validate their appropriateness.

However, the evaluation of policies that impact on Science 2.0 practices creates specific challenges, since they affect the foundation of most research quality indicators: publication, citation and peer review. It may be tempting to evaluate Science 2.0 policies in terms of their effect on Science 2.0 practices directly (for example, number of blogs, number of participants in research-oriented social network, amount of data in Open Access platforms). However, to guide implementation and validate policies, it is important to understand their eventual effect on the excellence and impact of research outcomes, and on the efficiency of research activities.

Policy makers should have access to robust policy evaluation methods that can answer in particular the following questions:

1. Which Science 2.0 practices require policy intervention, as opposed to practices that can develop organically within the existing research framework?
2. Which policies are effective in that the impact they have on Science 2.0 practices promotes excellence, better impact and higher efficiency of research activities? Which policies provide the highest return?

Science Europe calls for Science 2.0 policies to be driven by indicators that are based on research quality—essentially the importance, topicality, novelty, efficacy, relevance and impact (if appropriate) of the research being conducted with the assistance of Science 2.0 practices. Such indicators should be developed and evaluation practices should be trialled accordingly.

3 Adapting the Existing Research Environment to Science 2.0

Without completely rethinking the existing research policy and regulatory environment, it should be reviewed to ensure that it is conducive to a bottom-up uptake of Science 2.0 practices. Existing rules should not unnecessarily limit Science 2.0 practices, and existing incentives should not raise the individual cost of engaging with Science 2.0. These adaptations should—and can for the most part—be implemented rapidly; the benefits of developing policies in these areas have already been established.

3.1 Publication Practices and Open Access to Publications

The 2003 Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities[6] recognises the opportunity offered by the Internet to provide universal access to knowledge. It calls for all scientific research results to be made freely and permanently accessible online.

Openly-accessible journal publications are of considerable benefit in the development of various Science 2.0 practices, such as text and data mining or research-oriented social networks. The transition to Open Access should therefore continue to receive robust support, including to ensure that the quality of journal publications overall is not eroded in the move to Open Access, and that permanent archiving of the scientific memory is maintained.

Furthermore, in accordance with the Berlin Declaration principles, Science 2.0 practices that include the description of research results—such as online pre-prints, blogs and open notebooks—should be treated as contributions governed by Open Access. Organisations with

[6] The Berlin Declaration of October 2003 has been signed by almost 500 institutional research stakeholders and is supported in Science Europe's position statement on the Principles for the Transition to Open Access to Research Publications of April 2013.

an Open Access mandate should clarify that they intend research results to be openly accessible, irrespective of the form of publication.

The quality standards promoted for Open Access publications should also be extended to Science 2.0 practices, where appropriate. For example, good practices concerning attribution, including authorship and declaration of funding sources or organisational affiliation[7], should be maintained when publishing on a blog, or distributing data or source code. It should be possible to reference a permanent, well-defined version of the artefact in citations.

3.2 Framework Condition for Data Sharing in Research Infrastructures

Research infrastructures are key sources of research data. These usually involve long-term financial commitments and take time to adapt once they have been set-up. Data handling and sharing policies implemented by research infrastructure owners, operators and users will therefore have a disproportionate impact on the uptake of data sharing practices (see §4.1).

Framework conditions established for new research infrastructures (including intellectual property rights) should not be disadvantageous to operators or users who wish to provide Open Access to data, whether immediately upon production or after an embargo period. Research infrastructures that are evaluated externally, for example to obtain competitive grants, should be evaluated in part on their internal implementation of data sharing best practices— recognition of contributors and data ownership, platforms accessible to all participants, privacy or national security concerns, data archiving, standardisation of metadata, citability—, even if data access is restricted to consortium participants only.

3.3 Good Research Practices and Research Integrity

Rules against scientific malpractice should equally apply to new Science 2.0 practices. These rules should be reviewed regularly in light of changing practices. For example, plagiarism from a competitor's pre-print, blog, data or program source code should be investigated and sanctioned, as would plagiarism from a journal article.

3.4 Inclusion of Science 2.0 Outputs in Peer Review

While considering the impact of Science 2.0 practices on research evaluation may require long-term reflection (see §5.1), the uptake of Science 2.0 practices should not be curbed by unnecessary exclusion from consideration in peer review evaluation, for example for career promotion or project and grant selection[8]. Peer review has the advantage over other forms of evaluation, in that experts have the capacity to take into account the scientific importance of Science 2.0 outputs (such as pre-prints, software, datasets). These should therefore be considered in peer review, insofar as they are publicly available, and may significantly influence the standing of applicants in their community—for example a pre-print that has received high attention, a software or dataset with many users. Applicants should be allowed to present Science 2.0 outputs that are relevant in their discipline, and these should be shown to experts alongside peer-reviewed publications.

3.5 Public Outreach and Dissemination Schemes

There should be no bias against Science 2.0 practices in public outreach and dissemination schemes. Decision-making bodies should be able to comprehend Science 2.0 practices, and to make realistic assessments of their impact, both in comparison to traditional practices and in their unique characteristics. For example, a research-themed Twitter feed should be evaluated in terms of the people it can reach and the impact it can have on them in comparison to another method of dissemination (for example a museum exposition) as well as in terms of the proposed approach to utilise Twitter's communication model.

3.6 Learn from the Experiences of Adaptation

Research administration and policy actors whose activities are impacted by research practices that may relate to Science 2.0—particularly those concerned by the recommendations above—should implement experience-gathering policies. Experiences should be collected, analysed and shared, to uncover previously-unrecognised needs for adaptation and Science

---

[7] The importance of understanding organisational affiliation and funding sources goes beyond output-accounting. It is also a prerequisite to integrity, transparency, and the fair evaluation of researchers in a Science 2.0 research system.
[8] See also the San Francisco Declaration on Research Assessment.

2.0 practices. The opinions of 'users' should be sought, including those of a minority gender, social or ethnic background in their community. The experience gained in adapting existing policies should also guide the development of Science 2.0-specific policies and evaluation methods (see section 2).

4 Improving the Research Environment Through Science 2.0

Science 2.0 practices, such as Open Access to research data or data-driven research, have reached a level of maturity in some disciplines such that they cannot be developed further without robust supporting policies. Other Science 2.0 practices, such as research-oriented social networks, may provide tools to develop novel policies related to existing priorities, such as those in support of interdisciplinarity or knowledge transfer. The implementation of these new policies should be done in close interaction with research communities, in order to build on their experience. They should also be conducted as part of a robust, evidence-driven policy process. This means that their full implementation comes with a medium-term outlook.

4.1 Sharing of Research Data

The low cost of data storage and internet bandwidth makes sharing any kind of research data, including software code, accessible to any researcher who wishes to do so[9]. However, in the absence of an ecosystem that supports its subsequent stewardship – quality control, integration, curation, guaranteed archiving, citability, attribution, maintenance of software – there is little systemic benefit and little incentive for researchers to do so. Furthermore, current evaluation practices might not recognise researchers' contributions when they share data; research projects related to data stewardship (including replication of existing data) are disadvantaged in terms of funding, and results are hard to publish. Data sharing policies should focus on creating framework conditions conducive to the development of bottom-up data sharing practices, including Open Access data. This should build on the experience of large-scale data sharing projects in physics (LHC, PANdata), the Human Brain Project, or Open Source communities (GNU).

Financial support should be provided for data stewardship, accessible to projects, whole research communities (networks), infrastructure operators and users. Policies should consider issues such as the schemes through which financing can be channelled[10] and, in a context where priorities have to be set, what criteria should be used to take decisions on which data to invest in.

Large-scale sharing of data also implies an effort of standardisation. While standards should evolve within communities, research policy makers should explore their role in enforcing standards in a given community once it has reached a sufficient level of internal agreement (including mandating Open Access to data when appropriate), as well as promoting convergence between communities that share data but have different needs—for example when data is produced by one community and used by another.

4.2 Capacities for Data-driven Research

It goes beyond the scope of this document to explore whether data-driven research is essentially different from hypothesis-driven research or if it is a variation thereof. It is, however, clear that it requires specific capacities: distinctive skills leading to specific careers and possibly even different organisations of research practice—for example, data-driven science in some fields may require large research groups.

Capacity-building policies for data-driven research should be developed. The reality 'in the lab' of data-driven research is diverse, and capacity-building should encompass various research policy areas. Data-driven research is part of the core skillset in many disciplines and should be taken into account in career progression policies, including training and evaluation. Additional technical staff may be required to complement organic skills (for example, running data collection, or programming); hiring and funding practices should support this. A single research group may not be best suited to conducting data-driven research and may instead

---

[9] The novelty is the fact that all data may conceivably be shared. High value data such as that from the Large Hadron Collider at CERN or the Human Genome Project had always been conceived as a shared good.
[10] Funding for data stewardship could be included in project or infrastructure grants or could come as separate schemes.

engage with, for example, mathematicians or computer scientists. Policies in support of interdisciplinary research should include specific schemes to support this type of collaboration.

While human capabilities are at the core of data-driven research, infrastructures also play a crucial role. Section 3.1 describes data-sharing and storage infrastructures, which may be important for some data-driven research fields ('Big Data'). High-performance computing infrastructures in Europe should be strengthened further[11], taking into account the leading role of national supercomputing strategies in first-tier infrastructures and the need to share second-tier infrastructures that meet specialised computing needs.

4.3 Fostering Interdisciplinary Research

Research-oriented 'social' networks, such as ResearchGate, and other Science 2.0 practices that impact how researchers relate to their peers (for example virtual collaboration), represent a particular challenge and opportunity for interdisciplinary research. On the one hand, they may focus a researcher's attention on the work of an ever-smaller circle of peers whose work is very similar to their own. This trend may be compounded by the growing number of publications, leading researchers to further target their reading. On the other hand, it has been proposed that popular social networks, such as Facebook, can promote access to more diverse opinions, by giving access to so-called 'weak link' relationships whose backgrounds are more varied[12]. Similar effects may be obtained for researchers—particularly young researchers—if research-oriented social networks help them to discover results that complement their own research but have been produced outside of their own community.

Science 2.0 practices that impact how researchers relate to their peers should be considered as an addition to the 'policy toolbox', which can strengthen or serve as the foundation for interdisciplinary research schemes. Experience should be collected to understand how specific Science 2.0 practices that are proposed in interdisciplinary research projects can impact their outcomes, and this should be integrated in the evaluation of future proposals. Research stakeholders should engage with commercial providers of research-oriented social networks to ensure that researchers play an active role in shaping these services[13,14].

4.4 Science 2.0 for Knowledge and Technology Transfer

In previous sections, Science 2.0 practices were discussed essentially as internal to the research system. However, it is obvious that the same openness and interactions could have a profound impact on innovation policies. It could give entrepreneurs access not just to publications and patents but to a deeper grasp of the nature and detailed implications of research results, and *vice versa*. Science 2.0 practices such as research/innovation-oriented social networks or virtual infrastructures should be explored as tools to facilitate contacts between researchers and entrepreneurs.

Policies that support Science 2.0 practices should be coherent with the development of an 'innovation 2.0' ecosystem. The implementation of Science 2.0 practices should be evaluated to determine which have the potential to be of use to all innovation actors. Research actors should be prepared to engage with other innovation actors in order to extend or adapt researcher-driven Science 2.0 practices, without hampering researchers' ability to conduct research. For example, data sharing platforms might be encouraged to develop contractual relationships with third-party providers developing additional services. Conversely, the participation of industry actors in Science 2.0 practices should be encouraged—for example by contributing data to accessible research platforms.

Similar policies should be developed to support other forms of knowledge transfer, notably to the education sector and government.

---

[11] In June 2014, only two of the world's ten most powerful supercomputers where located in Europe, one in Germany, one in Switzerland. Both are the result of national high-performance computing strategies.
[12] E. Bakshy, I. Rosenn, C. Marlow, L. Adamic: 'The Role of Social Networks in Information Diffusion'; Proceedings of the 21st international conference on World Wide Web, pp. 519-528; 2012 (note that 3 authors are affiliated with Facebook).
[13] Facebook's algorithm that selects which posts are displayed to a user has a disproportionate impact on user experience, but remains secret (i.e. 'algorithmic governance'). This calls for research actors to engage with issues of algorithmic governance in the event research-oriented social networks play an increasing role in research practices.
[14] Individual researchers may have a limited capacity to shape research-oriented social networks using market forces: business models tend to distinguish users of the network from clients—who are typically advertisers or other organisations seeking information about users. Even if social networks have to provide an attractive experience for researchers, it remains that "If you are not the client, you are the product".

5 Rethinking the Research Environment with Science 2.0

The intellectual foundation of Science 2.0—a more open research environment and stronger interactions within communities, mediated by information technologies—may not only apply to the conduit of science 'in the lab' but also to the activities of research policy and administration actors. In this prospective section, some considerations are discussed in relation to their long-term role.

If Europe is to remain a leading force in global research, it is crucial that its research system remains supportive of excellent researchers—irrespective of nationality, language, gender, social or ethnic background. The ERA's diversity of regional, national and European-level research policy and administration actors allows research environments to be tailored to different research cultures and needs and gives more varied opportunities for the creativity of individual researchers to flourish. It does however require that ERA actors are prepared to anticipate trends, and to collaborate to exploit the benefits of the rich European research system.

In this section, two examples are given of long-term Science 2.0-related trends where different actors in the European research system may find common ground. Science Europe welcomes debate on these subjects, and will propose other such debates in the context of developing the ERA.

This document does not consider the impact of Science 2.0 practices, which are mostly English-centric, on linguistic diversity. It should also be noted that there is limited evidence about the positive or negative effect of Science 2.0 practices on for examples gender, social, and ethnic diversity. These aspects should be investigated and taken into account in future discussions.

5.1 How to Revitalise Peer Review without Jeopardising It?

Peer review may not be perfect, but no other form of evaluation can provide the same level of insight into the subtle reality of research. Indeed, many researchers are adamant that alternative forms of evaluation could jeopardise excellence in research. Nevertheless, there can be seen to be an increasing level of frustration with the implementation of peer review. Finding sufficient time to write expert opinions for peer review is an increasing problem for senior researchers. In addition, selecting reviewers to properly balance expertise and independence is challenging.

The current peer review process implies that each evaluation—whether it concerns an article, a position or a grant—is conducted as a standalone process. A Science 2.0 evaluation system may focus instead on building the profile of a researcher, a research line or, indeed, of a whole community, from various partial evaluations over time, as is done in social networks[15]. It may include more diverse outputs, in order to paint a broader picture of a researcher's activities (Altmetrics). It may strengthen the international nature of evaluation by seamlessly leveraging the opinions of a global community. It may even be more transparent if each component of the evaluation is separately accessible.

Private companies such as ResearchGate are already exploring such opportunities; industry may take the lead in shaping future evaluation practices if traditional public research stakeholders do not engage in this debate. Research organisations should consider which services are required from private companies in order to offer a transparent evaluation of research mandated by their public-service mission. They may further explore whether or not a public Science 2.0 evaluation ecosystem is desirable and what it would entail for public research stakeholders. Irrespective of the extent to which private partners are engaged, research policy makers could embrace the framework of Science 2.0 as an opportunity to revitalise peer review without jeopardising it.

5.2 Can Information Technology Revolutionise the Administration of Research?

A core activity of research funding and performing organisations (including the European Commission and its agencies) is to provide funding or employment for researchers. Within the ERA, principal investigators rely on complex funding portfolios, from different sources, and

[15] A scientific literature review can be found on the 'Transforming Peer Review Bibliography' website. Once can also consider early attempts to open peer review in e.g. BioMed Central portable peer review, Public Peer Review in Copernicus Journals or PubMed Commons—a post-publication review and discussion platform.

researchers have access to a variety of employment opportunities at all stages of their careers. This diversity can, and should, be seen as a strength of Europe. However, it represents a challenge for researchers; navigating this complex environment is time-consuming and opportunities may be lost because of a lack of information.

The reflection on Science 2.0 can foster a distinct but related reflection on the services provided to researchers by funding and performing organisations. Administrative practices inspired by and building on Science 2.0 practices— 'Science Administration 2.0'—may be an opportunity to strengthen the service provided by individual organisation, as well as the overall level of service in the research system. Private-sector actors have started offering services in this area[16].

For example, it may be a valuable service for researchers to provide rich data on available grants and position, and on their characteristics (conditions, success rates). The value of the data is multiplied if it is further integrated, analysed, and visualised. This might be achieved by encouraging the creation of an ecosystem of public and private service providers who create value from the raw data. In fact, it raises similar stewardship issues as those encountered by researchers when sharing data, such as quality management and standardisation.

Similarly, as part of their administrative duties, research funding and performing organisations collect a wealth of data about research practices, individual researchers, scientific trends, and so on, to which 'big data' techniques could be applied. The promise of big data might be that it provides a better understanding of macro-level trends, such as changes in scientific priorities. It might also provide a micro-level view that could for example help young researchers in positioning themselves at the cutting-edge of their discipline. These promises have yet to be proven, but their potential means that they are worth consideration. Furthermore, bibliometric big data analysis conducted by private companies has proven to be influential in many policy decisions—despite the fact that bibliometric data may easily be misinterpreted or over-interpreted.

As a final example, if research-oriented social networks become mainstream practice, organisations could benefit from integrating their services into these platforms. For example, funding opportunities could be advertised more effectively, and calls could be tailored on the basis of research communities' feedback and on international expert opinion, without the need for costly 'on site' consultations.

Science Europe is keen to engage further with the European Commission and other stakeholders on how Science 2.0 practices and thinking can strengthen a European research system that is excellence-focused yet diverse.

Science Europe is a non-profit organisation based in Brussels representing 52 Research Funding and Research Performing Organisations across Europe.

More information on its mission and activities: http://www.scienceeurope.org

For contacts concerning this document:

Dr Gilles Dubochet, Senior Scientific Officer
Email: office@scienceeurope.org

[16] As an example, Elsevier's Pure is marketed toward research managers as an all-in-one system for the administration of a research organisation. It includes features such as grant management, monitoring of research impact, etc. Performance indicators provided by the service are proprietary.