The 3rd SPARC Japan Seminar 2016
Future Standard Infrastructure Supporting Creation of Scientific Knowledge:
Reconsidering Open Science

Open Science in a European Perspective

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Abstract

Open Science is high on the political agenda. During the Dutch Presidency of the European Council in 2016 the 28 Member States adopted Competitiveness Council Conclusions on Open Science, and there was a Presidency Conference on Open Science that resulted in the Amsterdam Call for Action on Open Science. The European Commission has set up a European Open Science Agenda and installed a number of Expert Groups on topics like Open Science Cloud and Altmetrics. Several European countries have established national open science policies and strategies.
Other stakeholders, like universities, publishers, and funding organizations, are also elaborating on Open Science activities, including Citizen Science. At the same time, major changes in for example the ways of scholarly communication are hampered by first-mover disadvantages, or require major redistribution of means.
So where are we standing now? How could we induce change in the Open Science Ecosystem? How can we catalyse the transition to open access with respect to publishing? What would be needed to stimulate sharing of research data?
This talk will give a European overview, discuss these questions and open up for discussion on possible solutions. It will focus on publications and research data, although other aspects of open science and connecting science to society at large - including innovation - will also be touched upon.

Ron Dekker

Ron Dekker studied econometrics and started his career in labour market research at Maastricht University. In 1995 he moved to Tilburg University where his research focus shifted to data management. The latter was his starting point at the Netherlands Organization for Scientific Research (NWO): in 1997 he became the head of the Data Agency. Later he worked as a team coordinator at the Social Sciences Division and at the Central Programmes and Institutes Department. In 2007 he was appointed Director Institutes of NWO.
In 2013 he was seconded to SURF, the Dutch IT-innovation organization for Higher Education & Research, as acting director and in 2014 he was seconded to the Ministry of Education, Science and Culture as project leader Open Science in preparation for the Dutch EU Presidency. As of 2016 he is Seconded National Expert on Open Science at the European Commission, Directorate-General Research & Innovation. In March 2017 he will start as the Director of CESSDA, the Consortium of European Social Science Data Archives. CESSDA is one of the large infrastructures in Europa (a so-called ESFRI Landmark) and has its main office in Bergen, Norway.

Since I am seconded to the Commission, I must remark that I do not speak on behalf of the Commission, but I know what is going on in the Commission. I will discuss what open science is and then go into open science policy by focusing on publications and data and will try to explore a vision on open science.

What is Open Science?

Open science is a change in the way science is performed. It refers to the total research cycle from the conception of ideas through analysis, data collection, publication, and re-view. This trend is occurring due to digitization. The amount of data being produced is increasing exponentially and there is a need for transparency. For example, in psychology about half of the published results are not reproducible. Therefore, we must find new ways holding research accountable. Also, science needs to better connect to society at large including enterprises. We especially need to tackle the grand societal challenges of poverty and disease.

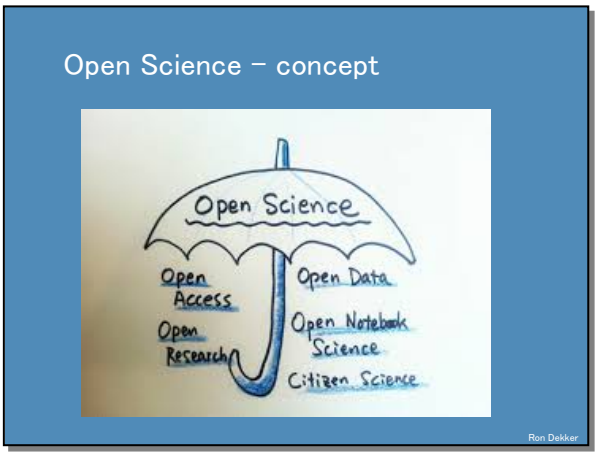
Open science could be seen as an umbrella term that consists of data, publications, software, 'open notebook' research integrity, and citizen science where citizens actively participate in doing science (Figure 1). It is difficult to have one definition of open science, but I like Michael Nielsen's definition of, "Open science is the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process." There could be reasons not to share immediately or to keep some barriers, but the core is to openly share as quick as possible.

To show how it is already happening, let us see what is available (Figure 2). There are a lot of tools already available. Sometimes this is compared to traditional science where the inner circle contains the ideas. Then you have data collection, analysis, publication, and review in the traditional cycle. However, the outer cycle shows that there is more interaction with the outside world. Therefore, open science is about connecting science.

European Open Science Policy

In 2014 the European Commission started consulting with stakeholders on open science, including researchers, publishers, funders, and societies. The main topics were publication, data, and research infrastructure.

These were the main drivers for open science (Figure 3). There were also barriers, one of which was quality assurance. How do we assure quality if it is made open immediately? How do we give



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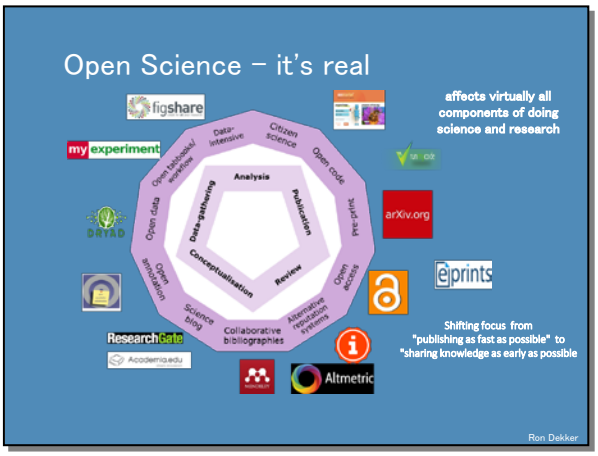
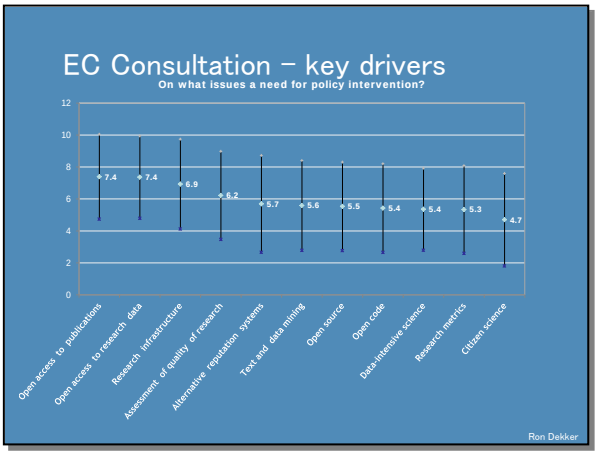


(Figure 2)

credit when we want to share data? Is there sufficient infrastructure to share data and knowledge? Are researchers and non-researchers aware of the benefits of current science? Therefore, we set a number of priorities on data and publication. This was taken up not only by the Euro Commissioner Carlos Moedas, but also by Sander Dekker, the Dutch state secretary of science.

The Netherlands was the president of the European Council last year, and we decided to make open science a priority. I will now briefly cover the results of this Dutch presidency and then come back to the policy priorities of the European Commission. During our presidency, we decided to have deliverables on data and policy. The task force on the optimal reuse of research data came up with a number of activities and recommendations on the training of data, data management, sustainability, and IP issues (Figure 4). It is very complicated to keep track of the optimal reuse of data. We deliberately did not call this 'open data' because it may suggest that the data should be made open immediately. Some data is sensitive or there may be first use rights. In these cases you would need to make yourself known to be able to reuse the data.

There was an expert report on data, and during the presidency we held a conference in Amsterdam where we worked towards certain goals (Figure 5). One is to have full open access by 2020 for publications. The second was to prepare a new approach for sharing data. The third is that we realized that we need a flanking policy, of which the most important one is to create a new reward and evaluation system that acknowledges and credits a person for sharing data. In the current system in Eastern Europe you are not rewarded for sharing data. You are rewarded for publishing in high prestige journals. You are not rewarded for education, sharing data, or sharing your knowledge. We have to change this reward system because otherwise there is no incentive to share. The fourth is a bit cryptic, but it means to share knowledge and have monitoring systems. To put it bluntly, some



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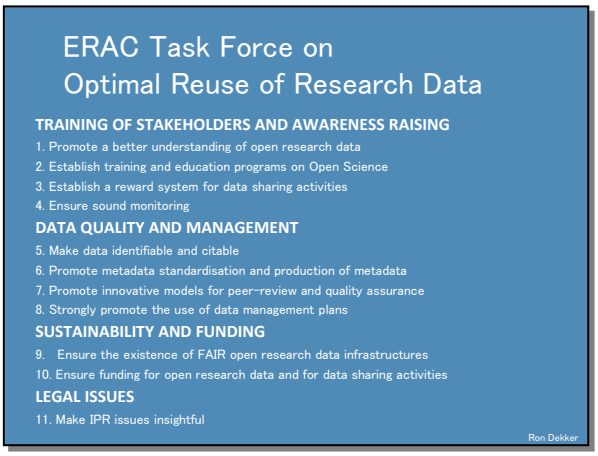

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(Figure 5)

nations or universities do not have any idea about the costs of publications. They know the contract cost of subscriptions, but not, for example, about the article processing charge for gold open access. Therefore, we have to collect these data and share information on the cost of publication. There were 12 very practical recommendations stating the problem, giving a direction towards a solution, and each stakeholder is addressed with what he or she should do (Figure 6).

Returning to the European Commission, in May last year the council's conclusions were accepted by all member states (Figure 7). The research ministers of the 28 member states of the European Council adopted these conclusions. It was a strong political statement by all of these

(Figure 6)

(Figure 7)

member states saying, "We want open science." There are also measures to do this. First is the importance of open science. The second is establishing an Open Science Policy Platform consisting of a delegation of the stakeholders. This Platform consists of 25 members from publishers, funders, universities, those in applied research, and young researchers. The Commission sought advice on how to proceed with open science. The third point is the direction in which open science should go. It is to make results open as soon as possible, to have text and data mining (TDM), and to retain copyrights. That could be one solution for getting out of the current situation of there being either paid access or no access at all. Open access in 2020 was very important because it is very important to state a date in a political statement, which we managed to do. All of the member states agreed to have open access to publications in 2020. As for data, the statement is more generic seeking 'optimal reuse'. Data should be a public good, but that opinion is not shared by all researchers who work on the data.

In Europe we now have a strong policy statement. We have agreement among all of the member states. We have national policies on open access and on open science, but how do we put this policy into action? The Commission came up with an agenda that introduced expert groups, this policy platform, and implemented open science in its programs. Like the Amsterdam goal, this open agenda deals with the barriers, how to give incentives to provide infrastructure, and making open science normal science. Open science should become a normal way to produce and to share knowledge as soon as possible.

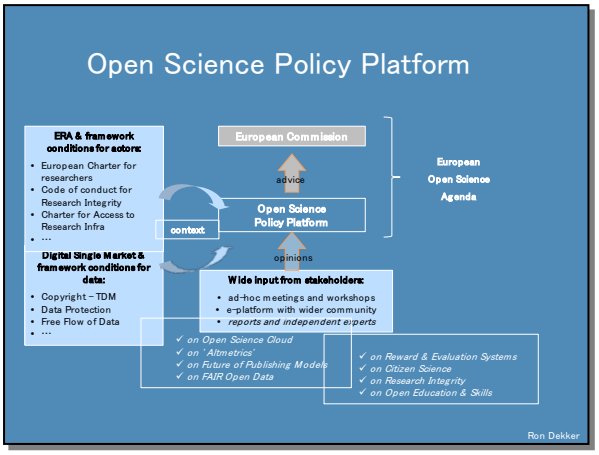
In this agenda it was decided to focus on eight

key issues: reward systems; measuring quality and impact; the future of publishing models; findable, accessible, interoperable, and reusable (FAIR) open data; the European Open Science Cloud; research integrity; citizen science; and open education and skills. As for quality, the current journal impact factor is a proxy for measuring quality of journals, not research or articles. The European Open Science Cloud is meant act as an infrastructure for the data and all research output. As for research integrity, making results reproducible is important. The Commission installed or will install expert groups on these items and also instilled this policy platform. This policy platform consists of 25 stakeholders that advise the Commission and is expected to have an overarching view of these eight items on how the European Commission can proceed on fostering and catalyzing the transition to open science.

Using a chart to explain this, on the left-hand side there are the inputs (Figure 8). The platform can have its own working groups. In the end it will advise the Commission, but also take results back to organizations. If they agree on a measure in the Open Science Policy Platform then it can be easily implemented by all the stakeholders.

The Commission also implemented open science in its research programs, of which the eight-framework Horizon 2020 program is the most important. There is an obligation to provide open access on publications either green or gold. You have to deposit as soon as possible, and make it available after between six and 12 months depending on the discipline. The cost of gold open access is eligible to be paid from grants. The same goes for data. As a grantee you are required to deposit the data in a repository and to provide access. We want to utilize this FAIR data statement and also share the data beyond publication.

There was a pilot with data management plans (DMP) since they create awareness among researchers that they create something that is valuable to other people (Figure 9). The pilot was voluntary and about two-thirds remain from the pilot program. Outside the pilot program, an additional 10% opted in voluntarily. We concluded that this pilot will be extended to cover all programs in Horizon 2020. It is a rather easy and simple procedure where researchers say what data they will generate, how they will make the data available, and they are asked to provide information on the curation/setup of the data. This is to create awareness among researchers and to get these data out of their laptops and into institutional, national, or



(Figure 8)

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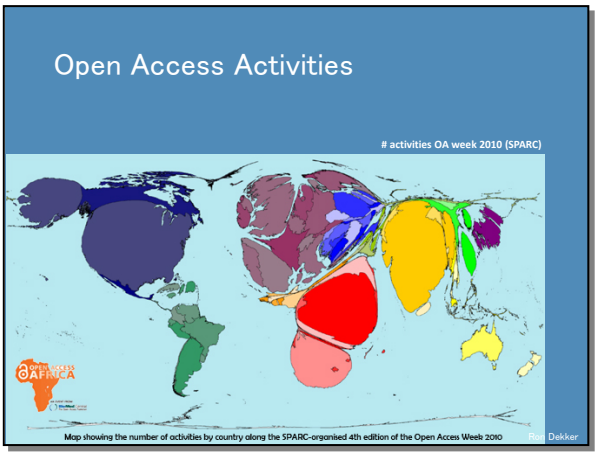
disciplinary databases. Therefore, this data management plan is quite important and is a necessary condition for sharing data.

These are the policy actions to make sharing data and publications concrete at the Commission. We have a political statement, policy, expert groups, a stakeholder platform, and we have included it in the grant regulations. Internationally we also see a lot of support for these data and open science. Most countries now have a policy on open access. Indeed, the G7 made a statement last year, and it is the intent of the G20 as well. Open science will be on the agenda of the upcoming G7 meeting in Europe, specifically focusing on reward systems and cloud infrastructure. This agenda item is prepared jointly by Japan and the European Commission.

Open Access of Scholarly Publications

Moving on to publications and data, to give an idea of who is dealing with open access policy, I used a slide from SPARC 2010 to show the countries active in open access policy (Figure 10), which shows it is on the agenda in many countries. However, looking at the population developments predicted for 2050, there is a huge shift to Asian countries (Figure 11). That is where the potential for science, innovation, and economic growth is since that is where people live. It is clear that there is a huge potential outside of science if we can better connect science to society.

Coming back to publishing, each year there are about three million publications (Figure 12-13).



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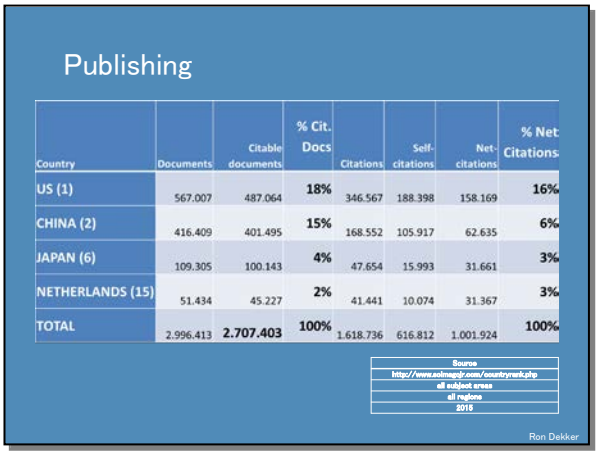

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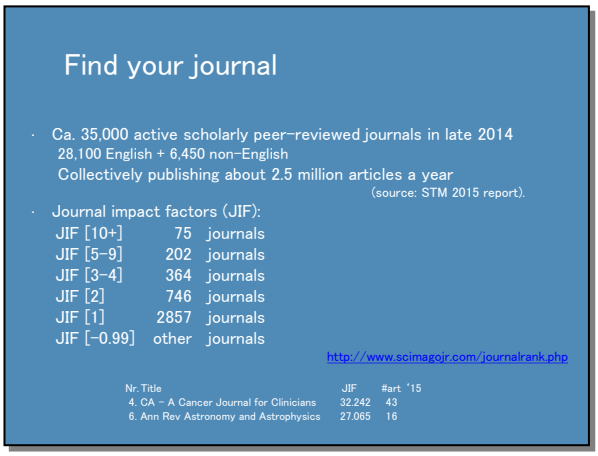


(Figure 13)

90% are citable, and about half of them get a citation. If we subtract self-citations we end up with about one million citations for 2.7 million papers, so only one in three gets cited for an impact factor of 0.3. However, some papers have impact factors of 30 or 40 which means a lot of people will not have any citations at all. For whom are we publishing all of these papers? Who are we sharing this knowledge with? How do we end up with the readers? Looking at the data you can see that the Netherlands is comparable to Japan.

Finding a journal can be difficult since there are 35,000 journals. Moreover, only 1% of these 35,000 have an impact factor of five or more, and just another percentage have an impact of three or more. In the Netherlands researchers are encouraged to publish in journals that have an impact factor of two or more, but that accounts for only 4% of all research journals.

Regarding relevance, if you want to have a high impact journal you should write a review because that gets cited most. However, taking astronomy and physics as an example, in 2015 there were only 16 papers accepted, so you have to be one of these 16. After that you get cited, but is this science? Is this what we are spending our public money on to get into one of these journals? I think it has become a goal in itself to be in these journals.

Publishers make full use of the internet by subdividing markets with the help of IP addresses. There are package deals that make it very attractive to subscribe to many of the journals, but it also makes it difficult to quit one because then you have to quit the whole deal. This journal impact factor also helps to have an economic lock-in that is very difficult to step out of. That is because the other stakeholders use journal impact factors as a proxy for quality. It happens in the research councils when deciding on grants. It happens at the universities and in university rankings. There is a first-mover disadvantage. If you decide to step out of the system you will not be in these rankings anymore. That might have political or monetary consequences.

Therefore, there is an incentive to publish in high-prestige journals instead of doing risky research because you have to have significant positive results. If you have non-significant or negative results then you will not be published in a top journal. This will lead to publication bias. As an example, in clinical trials there is a bias towards positive clinical trials, whereas if you go and search on the internet you find as many negative trials or those with non-significant outcomes. We only get part of the information, so we need to change this reward system. On the other hand, the current system pays off for researchers and publishers because researchers give the publishers their copyright. This allows publishers to run a business and provide excellent articles thereby increasing the value of the journal. Publishers give the researchers reputation, and that reputation helps researchers to get grants or gain prestige within their university.

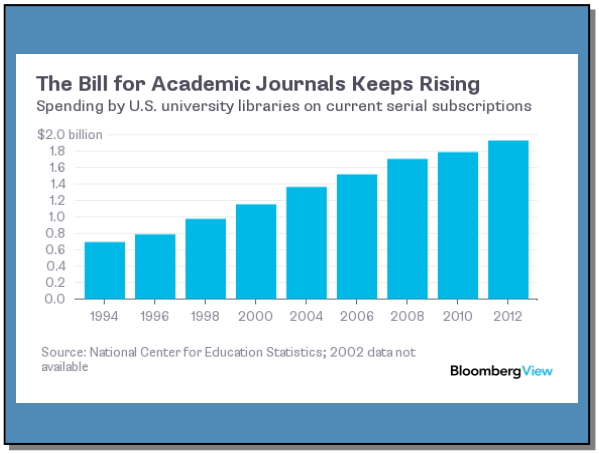
Although we could say this is a win-win situation, someone has to pay the bill (Figure 14). It is the libraries or the universities who have to pay the increasing costs of the journals due to price increases and more and more journals becoming available. That was one of the reasons to look at other models.

Why do we want to move towards open access? First of all, it is feasible to make use of internet technology where it is easy and cheap to copy and

distribute. Also, funders want more return. It is not only about publishing, but it is about sharing your knowledge and outcomes. The impact should become broader, not only the scientific impact, but the impact on society or innovation.

An important principle is that the results of publicly financed research should be publicly available. Research that is worth funding should be worth sharing. If we want to connect science with society we have to get better access to the publications and the output. It may benefit science because people are now focused on the outcomes within a discipline. Elsevier's STM Digest is meant to explain what is happening in disciplines. This is not used by the general public but is used by researchers to learn about other disciplines. Therefore, it is helping science to move towards action. We can work on improving integrity and trust in science.

There are different variants of open access such as gold, green, and hybrid. However, there is a lot of misunderstanding on open science. It is not an obligation to publish. It is not at odds with patenting. If you want to patent, you first have to patent and then you publish regardless of whether this is in a traditional or open access journal. There is no difference in the peer review process.



(Figure 14)

Both have peer review. Yes, there are predatory journals in open access, but there are also lousy journals in the traditional system. Some journals even copy existing articles and set it on a subscription model.

Therefore, if we want to have open access, we need to have these policies. As I said, most countries already have these policies, most on green, some on gold. I think that perhaps the most elegant policy is at the Gates Foundation. It is one page and lists five items. Essentially, it says to publish immediately in open access, share the data, and that the Gates Foundation will cover the costs and will pay a fair price. There are also no exceptions to this policy and it has been enacted after a two-year incubation period. Therefore, I think in open access to publications we ought to know what direction to go.

Optimal Re-use of Research Data

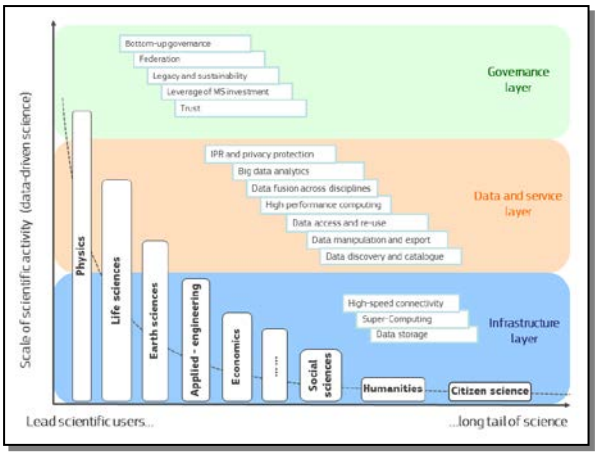
If we look at the optimal reuse of research data, it becomes a little bit more complicated. At least in Europe, publishing is in a transition from one publishing model to new publishing models.

Research data is a combination of items. In the European Commission there are three pillars. The first is the European Open Science Cloud (EOSC) taking care of the infra-structure and making connections with the content. ES-FRIs are large research infrastructures producing a lot of data and are part of the content. The second pillar is the European Data Infrastructure (EDI) providing high-performance computing networking software. The idea is to end the silos, to have large-scale European HPC, networking, software, and to combine these services or activities into a service. Therefore, it is infrastructure as a service. As a

researcher, I have some questions. I need storage and computation. I also need to connect with my colleagues. This should be provided as a service. The third pillar is to widen access, and that includes small and intermediate companies, industry, and government.

To focus on the EOSC, the former chair of the committee once said that it is not European, it is international. It is not open because it may be closed for some data. It is not science because it is science, innovation, and public. It is not a cloud, it is real. It is data service on the ground that provides the facilities. It is creating an environment for researchers to store, manage, and reuse the data. We are aware that there is already a lot of infrastructure at universities, institutes, and on a national/European level with supercomputers. The challenge will be how to connect this and to have a federation of existing and new infrastructure. Governance issues and how to combine these facilities are covered in EOSC report released in October of last year.

To address one of the items, it is about setting up governance, providing data/content and new services, as well as having the infrastructure up and running (Figure 15). That is the challenge of this cloud. One of the attempts of the Dutch



(Figure 15)

DANS Institute is to provide a kind of Michelin Guide for data. We could come up with a score by creating a score through five questions on each of the first three parts of FAIR (findable, accessible, and interoperable). By taking the average you get a general score. This is the first way of making the data known. I think one of the challenges is to make the data findable. There is a lot of data out there, but how do I find it?

I would just like to stress that clouds already exist, for example at the National Institutes of Health with the NIH Commons. The National Science Foundation also has a cloud, and there are commercial clouds by Microsoft and Amazon. What strikes me is that these are mostly US examples. They start with pilot, such as the $6 million cloud that the NIH is running. I think in Europe we are more top-down. We think about governance and want to have everything in place before we start, but this approach gives you a head start because you have the backbone and the facilities in your country. If the US invests in clouds then US research will invest clouds, and it will be national in-vestments. If Europe wants to invest in cloud and we go to these providers then it will be an international investment. We should also tune up and prepare national providers or European providers to deliver these services. For this we need this pilot.

As I said, data should be findable, but in order to be reused the data should be trusted. This 'Data Seal of Approval' by the DANS Institute and WDS of Japan provides a tool that gives confidence that the data can be found in a good format and are reliable (Figure 16). They also provide identifiers for datasets. That is important to be able to point to the data if you want to give credit to a researcher

who made it.

However, on sharing and optimal reuse of data it is a cultural change to bring trust to stimulate sharing. For this we need to be able to refer to the data, so they should have identifiers. However, we must also reward or give incentives to the data producers to share. Also, we need authentication of the data producers and users. Ideally, there would be a kind of single sign-on to get access to the data and make yourself known if you provide or are using the data. Especially in life sciences and social sciences we have to take care in how to deal with sensitive data. Some data cannot be open on the internet but are still relevant for research. How do we tackle that? To conclude on data infrastructure, the direction is less clear. We know we want to have incentives for sharing. We need a reward structure and we need identifiers, but how to achieve this is not yet clear.

A Vision on Open Science

Looking towards a vision on open science, I will start with publications and move on to data. Looking at the trends that an association of publishers came up with, you can see 'The Article in a Hub and Spoke Model' and 'Data as first class Research Object' in STM Tech Trends 2015. Therefore, data becomes a research outcome and should be shared.

Outlook 2020 is about big data and the combination of data and artificial intelligence (Figure 17). A machine might become a new reader going through the articles and data, and it may be assisting researchers. For this, it is very important: to de-liver precision information. I can only read 300 to 400 papers out of the three million published per year, so I need some help in selecting. In the early days you could read just one or two journals, but the number of journals has in-creased. Relevant articles may be found in other journals. I need help filtering.

The value added in publishing is to assist in filtering. For example, my 15-year-old son will not pay for content. He will go on the internet to find music and movies, but he might want help in finding it. For that he has his social network. However, in research we need help in finding relevant information. In publishing it is clear that an author wants reach as many readers as possible, while the readers want to have relevant articles. Therefore, there is a market. There is the supply of publications and there is a need for these publications.

The new direction is to have a platform strate-

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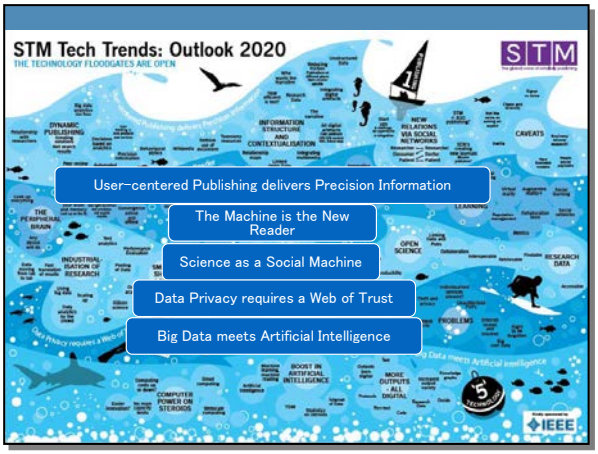


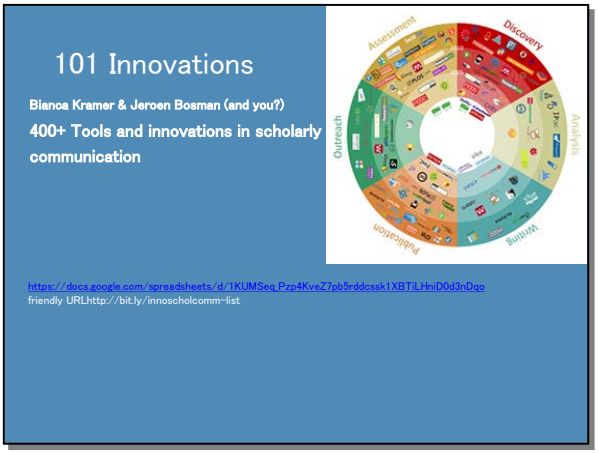
(Figure 17)

gy. This figure is based on an article in the Harvard Business Review which says if we want to have a strategy we have to think differently (Figure 18). We have a shift in focus. It is not about marginal costs, but is on interactions and exchanging value between producers and users on that platform. These plat-forms have the owner, the provider, the producers, and the users. One big example is Apple. They own a platform that is run on the iPhone and the iPad that is not about calling, but applications. It is the App Store and iTunes where you find the users. The success of Apple is in making this connection.

Another example is the Sony PlayStation. With the PlayStation 4 Sony offers a monthly subscription that allows players to connect to other players worldwide such that people can play against anyone in the world. Therefore, adding value on the platform is what counts. I think this should be the direction for publishing to have good connections and good interactions between users and producers.

I think you have seen this one (Figure 19) before in an earlier presentation (in the 3rd SPARC Japan Seminar 2015). 101 Innovations makes note of all of the tools that are available, but it should now be called '400+ Innovations' since that is now the number that is available when doing open science.

This shows the traditional publishing process (Figure 20). You write an article, you submit it, it gets rejected, you submit it again to another journal, it get peer reviewed, it is rejected or you should improve it, the article is accepted, you publish it, and it is in the journal. In the paywall model, people out-side science do not see this and have to pay $30 to get access to this article unless they have subscription (Figure 21). With green open access, we have an embargo or a preprint that is available (Figure 22). Therefore, we came up with gold open access changing the end of the process (Figure 23). We take care of payment and make it available for everyone. However, will this gold



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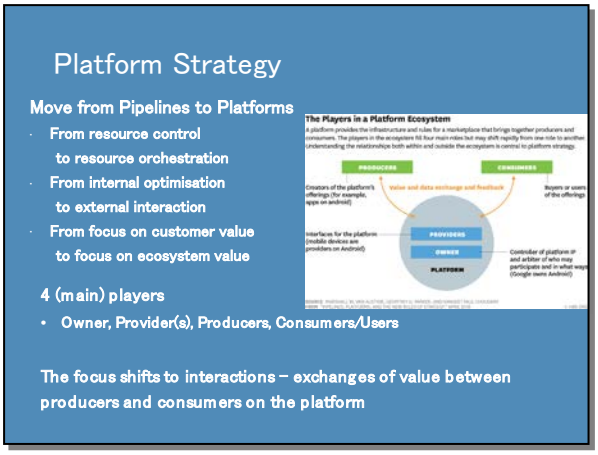

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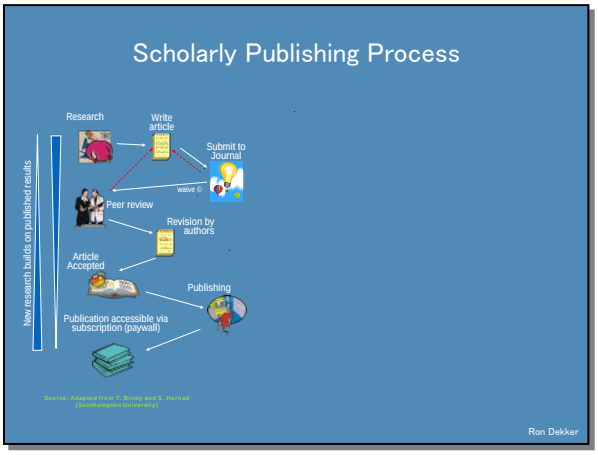


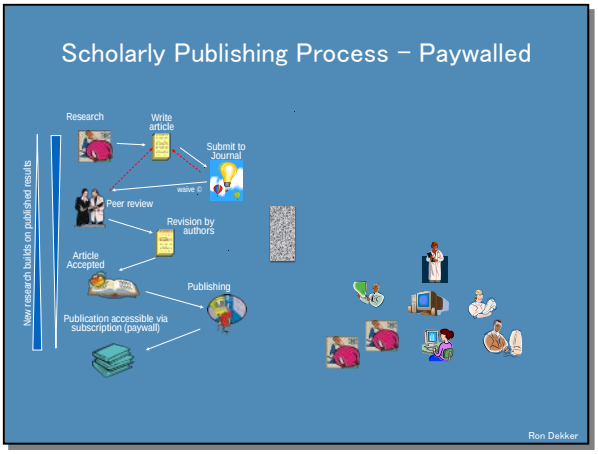
(Figure 20)

model become the standard or will it exist next to the other models?

In publishing there is this new idea by the Wellcome Trust (Figure 24). It is called 'open research' where an article is first published within one week. Then the article is peer re-viewed openly and the outcome is available. This also applies to lab results or data in addition to publication. I do not know how they are going to review data, but I think they will find a way of guaranteeing the quality of a dataset. This is a shift in the way of doing things by first publishing and then doing quality assessment. Taking a further step, we could put research back in the middle again (Figure 25). I have research and I decide whether I make it public or not. If I make it public I can send it to a traditional journal, to gold open access, or to open research. I do not go for peer re-view and just have the preprint posted. Then I can get the access. That makes it very easy for researchers.

It also makes it very easy for funders since it is very easy to be open access compliant (Figure 26). This model has a FAIR price of getting peer reviewed of about USD$750. This could be a new way of doing things, but it is still within the existing journal system.

Another trend is found in preprints. If funders are willing to acknowledge preprints that get an identifier and say it is acceptable for grants to refer to a preprint then it will help young researchers. If you are on a two-year postdoc grant you do not have time to submit a paper that takes a year



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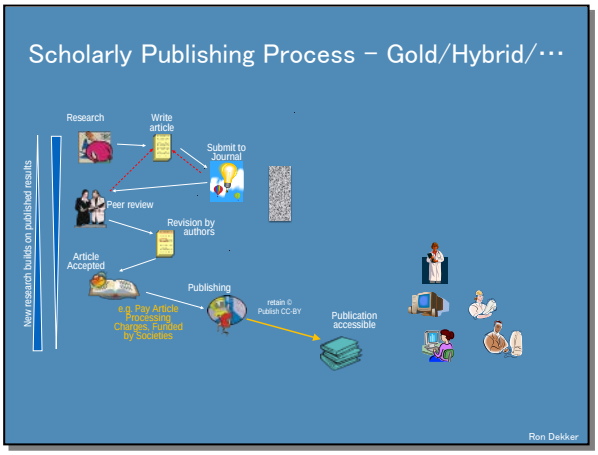
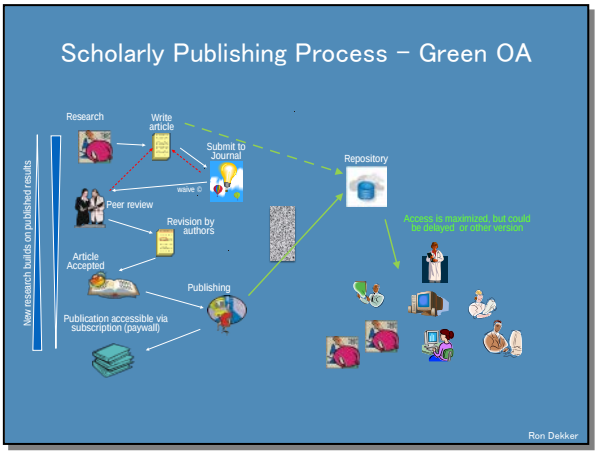


(Figure 23)



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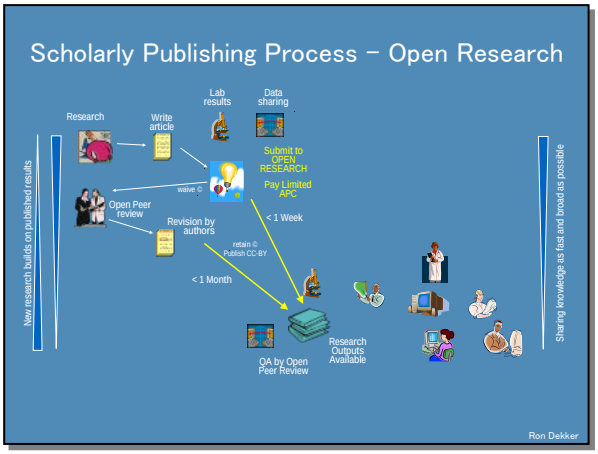
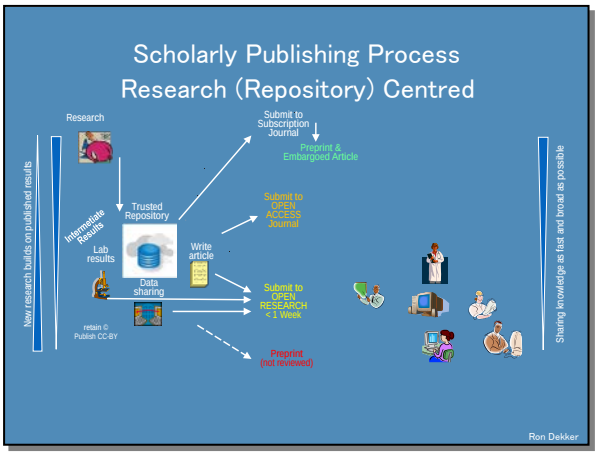


(Figure 24)

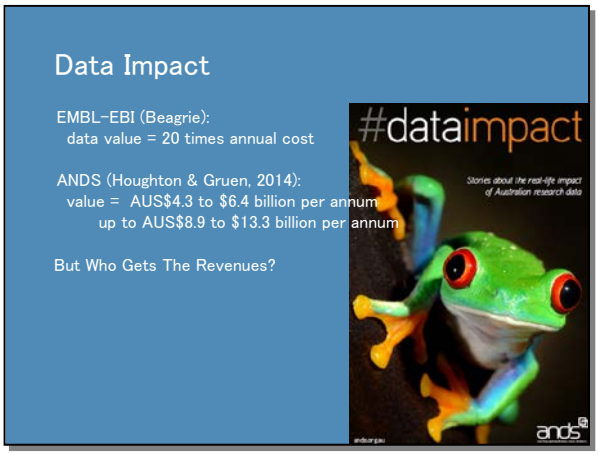
to get published. If you get a timestamp on this preprint then you can use it in your new application for the grant, which will help. It will also speed up publishing and the sharing of knowledge. We could have a system of trusted repositories for preprints. These are some of the trends in sharing knowledge in terms of publications that show future directions.

On data, I need your help (Figure 27). There are calculations of the enormous value that data have if you take into account the labor needed to restructure these data. However, if a re-searcher puts a lot of effort into preparing data and shares it, then someone else will get revenues through saving a lot of time in producing a paper or new knowledge. Therefore, how do we set up a market on sharing data? That is one of the main questions. We have infrastructure, so there can be pilots. We can also have discussions as to whether we should have a national policy for all disciplines, by-discipline work internationally, or do both and see how they come together.

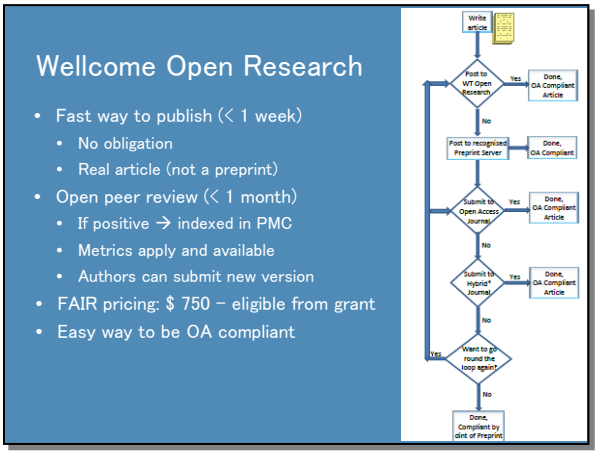
One example of a win-win situation that it is critical to create a market is the Structural Genomics Consortium (Figure 28). The pharmaceutical companies participate in a joint effort until a moment when they split and compete. They set up a trusted party and had 10 research groups. The trusted party asked each of them, "Give us your top three proteins that you want to investigate." They were collected and a top-30 was created without revealing what the companies were working on or



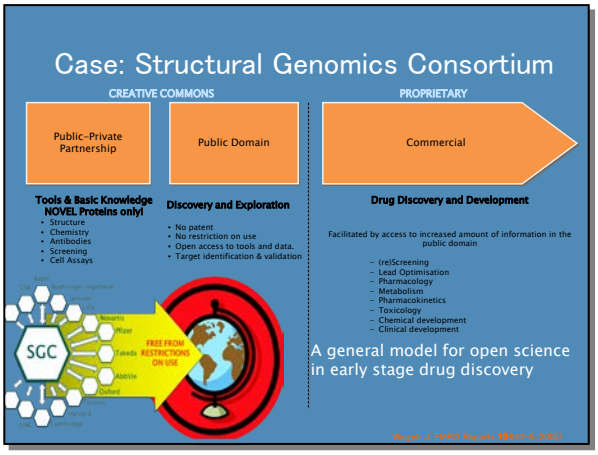
(Figure 25)



(Figure 27)



(Figure 26)



(Figure 28)

interested in. The researchers agreed to work on these top-30 proteins. This is a win-win situation. You have a lot of data and you have a lot of research capacity. On data we have to find this demand and supply, these producers and users of data. That will be the challenge for data.

I can see the value of data and also the enormous supply of data, but we have to make them findable. That is just the basic idea. Perhaps it could be the libraries that could play an intermediary role since they know what is going on in their university. Libraries are also connected to other libraries, so they know what is going on elsewhere. If you have a question on data, the librarian could help you find what you need. Therefore, we need this intermediary.

In conclusion, we should be part of this new era of open science because that will be the trend. We want to reach more people and have greater impact not only in science, but also society. We could prevent duplications of effort or publication bias. We need to preserve data for future use in order for them to have an impact in science, society, and innovation.

The challenge is in how to cooperate, innovate, and share. I am happy to be here in Japan. My first acquaintance with Japan was twofold. One was with a very traditional film, The Ballad of Narayama. The other is the book The Knowledge-creating Company: How Japanese Companies Create the Dynamics of Innovation where it was explained how to have innovation in traditional companies. It is the combination of tradition, understanding the past, and having the guts to innovate and change that will lead us to new ideas in open science, in reusing data, and in making publications open access. A South African proverb says, "If you want to go fast, go alone. If you want to go far, go together." Thank you.

● Fukagai I am Fukagai (Prof.) from the Yokohama National University and a member of the SPARC Japan Governing Board. Nowadays there are many active discussions about open science also in Japan. Looking over the history, scientists had changed their behavior, when knowledge limited to some people was open to public through the letterpress printing of Gutenberg. The similar thing is happening today. People are changing behavior accordingly in the situation which information is flying around in the network.

E-journal is just a part of tradition, because it is just an electric version. But now many people commit processes creating knowledge through exchanging information in the network, and as a result, they share and get ideas. To speed up this movement is open science, I think.

However, there is a barrier against open science: scholarly outcomes are belonged to a researcher and he or she is evaluated with impact factors. Scientists tend to focus on the narrow area in order to get high attention. On the other hand with a broad of view, they should make the outcomes open to let the human knowledge rich. We are facing this dilemma.

Under the condition, some funders decide the outcomes funded by the public grant need to be open. How do you think about that? Is it enough for open science?

● Dekker We are in a paradigm shift because we must move from making the print version available

on the internet to fully digitally-born outputs. I like Wellcome Trust open research because it focuses on both the traditional story telling article and also intermediate results. You can publish and share important data if you want to. The journal Science Matters allows publication of intermediate lab results if you think they are important for your research community. We have to find new outputs beyond traditional publication.

In measuring these outputs we will need new indicators beyond journal impact factors. However, if we broaden the outputs I think that the metrics will follow. The funders should reward these alternative or new outputs. If you have made important contributions to innovation or to a societal discussion then that should be rewarded by funders and universities. There are examples of universities and medical faculties having different reward systems for re-searchers, which is where it should start. Funders should request their committee members to stop counting publications. An alternative could be to ask the reviewers to go through the top-three or top-five publications instead of adding up impact factors, which makes no sense. You can-not compare impact factors over disciplines since you are comparing different things. The DORA initiative states that they will use qualitative information to assess research. That is the way to go, and we should also acknowledge the value of preprints and other types of output.