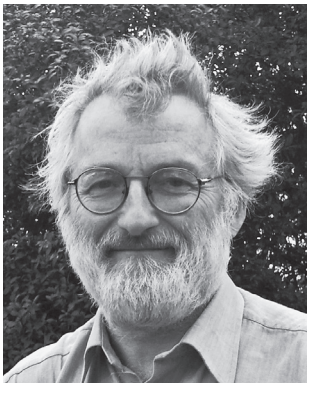
Chapter 29

Information flow: the basis for sustainable participation

John Sulston



John Sulston was born in 1942 in Great Britain. He began his studies in organic chemistry at Cambridge University, where he also obtained a PhD in the field of molecular biology. In his research, Sulston observed the cell division and differentiation in the development of tissues of the millimetre-long worm *Caenorhabditis elegans*. He was able to show that specific cells undergo programmed cell death as an integral part of the normal differentiation process. Sulston also identified the first mutation of a gene participating in the cell death process. In 2002 he was awarded the Nobel Prize in Physiology/Medicine, together with Sydney Brenner and H. Robert Horvitz, for their discoveries in relation to 'the genetic regulation of organ development and programmed cell death'. Professor Sulston was one of the founders of the Wellcome Trust Sanger Institute, where he led a team of several hundred scientists in the United Kingdom's contribution to the Human Genome Project. Since retiring as Director of the Institute in 2000 he has worked to ensure that information on genetic data remains freely accessible.

In tackling climate change we are participating in a game of prisoner's dilemma[1]. In this game each of two prisoners is invited to testify against, and thus betray, the other. If both prisoners testify, they each receive half the maximum sentence; if only one testifies, he goes free while the other receives the full sentence; however, if both remain silent, then both receive light sentences.

By sharing and acting upon our knowledge we have the opportunity to mitigate climate change. The great danger is that each of us tends to betray the group by striving for advantages over others, and if we persist on this course we and our planet will suffer dire consequences. The good news is that the climate game is a repeated version of the dilemma, in which the 'prisoners' have the opportunity to increase trust by seeing how the other responds. It is essential that we exploit this opportunity by promoting information flow in an equitable fashion. Only in this way will the necessary level of trust be attained for everyone to give up a little, so that we can collectively survive and thrive. Such levels of trust come easily to small tight-knit groups; the challenge is to develop mechanisms to achieve trust on a global scale.

The practice of science involves two sometimes conflicting types of activity. One consists of research and discovery – ranging from hypothesis-driven, problem-oriented research to the systematic amassing of data. The other type of activity is the open dissemination of information. Science has developed mechanisms to encourage both. The result is that we can all 'stand on the shoulders of giants' – or more mundanely, we all contribute to a rich mulch of knowledge out of which the new shoots of discovery grow vigorously.

It is particularly important that fundamental knowledge is placed in the public domain, so that all may share this information and use it for different purposes. Equally importantly, this approach engenders trust. However, there are many opposing forces that work against sharing knowledge and resources, and present a grave threat to effective cooperation. Because combating climate change is inherently a joint activity, it is especially important to promote sharing of information in this area.

Let us first consider various networks that are important for information sharing.

Examples of information networks

The entire process of scientific communication, involving informal contacts, conferences, and peer reviewed publication, is essential for science. It assures accuracy, since errors or falsification usually come to light quickly, and is the basis for attribution of credit.

[1] A classic example in game theory. For more information see http://en.wikipedia.org/wiki/Prisoner's_dilemma

Until recently, most major **scientific journals** were accessed by subscription, which included a healthy profit margin for the publisher. This worked reasonably well for well-funded scientific communities in the wealthy countries, but excluded less well-endowed scientists and civil society from access. With the arrival of electronic versions of these publications, and the possibility of linking them for easy literature searching, researchers began looking for ways to circumvent the barriers associated with for-profit mechanisms (see Fig. 1). Consequently, a movement towards open access publishing is under way, in which the researcher pays the costs of publication, and access is free to all. This trend is not without its problems. One is that whilst it provides less well-off researchers with access to the work of others, a special fee exemption needs to be made for them to publish their own work. This may become harder to arrange as the number of scientists in developing countries grows. The existing for-profit publishers have mounted a strong rearguard action to protect their position. In addition to independent commercial publishers, their ranks include many learned societies, who have traditionally derived a substantial part of their income from publication. In cases where information has been published in the traditional way, organisations such as SciDevnet help to provide access for scientists in developing countries.

Public databases are central to many fields. For example, three large databases (in USA, UK and Japan) collectively provide a repository of basic biological information. They began by storing DNA sequences, and are progressively extending their role to cover a wide range of data, including other sorts of nucleotide sequences, protein sequences and structures, higher order assemblies, and software tools. Data may be associated with peer reviewed publication, or may be entered in raw form. The databases can be accessed freely by all users, and may interact with other publicly funded sources to cover specialized applications. From time to time these databases come under threat from entrepreneurial rivals, but so far they have survived. A continuing difficulty in Europe is that the EU Research Framework Programme is so far unwilling to support large-scale infrastructure in life sciences, and so EU funding for this purpose has to come through individual research projects. The resulting instability is a constant threat. A further problem in Europe is the Database Directive, which gives excessive rights to proprietors, protecting not only the form of the database but also the actual data within it no matter how it was obtained. James Boyle of Duke University and others have shown that the Directive was a misguided step, not only endangering information flow, but also failing to benefit database proprietors. The importance of public databases is illustrated in Figure 1.

Part of the information stored in these databases came from the Human Genome Project. From the outset the Project's remit was to make its data publicly available, and this was reaffirmed in the Bermuda Agreement of 1996. Against some strong

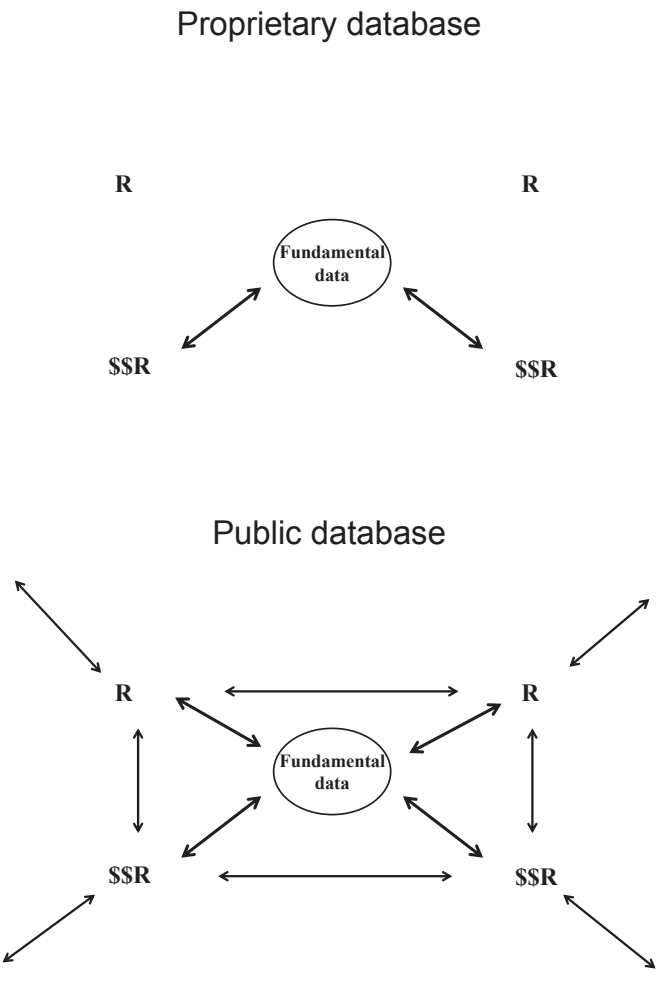


Fig. 1. Private and public databases. The ellipse represents the database and the arrows lines of communication. In order to preserve a viable business, the proprietor of a private database must insist that knowledge is not shared with others, otherwise it would leak out and the database would lose its financial value. This is not a satisfactory structure for holding data of fundamental importance. In addition to the obvious inequity of access for those who cannot pay, the resulting inhibition of communication is devastating to science. An important feature of the public database is that the user has access to all the data at once, to search at will and to compare with other databases. This allows the operation of novel and powerful algorithms, which would be blocked by, for example, a pay-per-view system.

opposition, the Project succeeded in its aim, and the outcome has been highly influential in keeping much biological information in the public domain. The Human Genome Project has occasionally been criticized for giving away data to profiteers,

but that was unavoidable. The huge gain is that comparative analyses of data are straightforward, without barriers of any kind, as a result of which the value of information is enhanced exponentially as more is added.

Meteorological data is partially privatized, particularly in Europe, thus limiting information exchange. This is clearly of major significance for climate research. The same situation applies to **geographic maps.** For example, in the UK the privatisation of the Ordnance Survey (the national mapping agency) has had a very negative effect both on fair use by individuals and on the development of value-added products. These are both examples of a protectionist trend that misguidedly seizes the opportunity to collect fees while ignoring both the hidden costs of collection and the long-term consequences. All information relevant to climate change should be made openly accessible; the Global Earth Observation System of Systems (see Potsdam Memorandum, this volume) will help in this aim.

Free software holds its own in the commercial as well as the academic world. Its extensive use in, for example, the banking system illustrates the compatibility of open structures with profitable activity.

The **World Wide Web** needs no introduction. It is interesting to note that the Internet originated in military requirements, but was transformed into the remarkable communications system that we have today by the work of Tim Berners-Lee. Its efficacy and independence is a model as well as a vehicle for exchanges on many important contemporary issues, including global climate change.

NGOs play a crucial role in many areas of human endeavour. Their role in climate change is already apparent. The term civil society has come into use to describe the coherence and importance of this powerful yet loose grouping. Its significance arises from the fact that direct government power stops at national boundaries, whereas the power of transnational corporations does not. Since governments (and their collective embodiment in the UN) are very susceptible to lobbying by well-endowed vested interests, NGOs are vital in providing a democratic balance.

As the most representative multinational forum, the **United Nations** ought to be the ultimate vehicle for information sharing, and indeed it is of immense (though widely underrated) importance. It has problems of manipulation by powerful interests, and is frequently accused of excessive bureaucracy and even corruption, not unlike many governments. In the long run an important part of our global agenda should be to build on the success of the UN and to improve transparency and trust in that organisation.

The **international patent system** is of increasing importance in information flow. For many it is *the* way of sharing. However, it is a double-edged sword that can block exchanges as well as facilitating them. For example, information and materials provided in scientific publications are, or should be, available for others to use,

but this freedom is being increasingly interfered with by the growing demands for intellectual property (IP) rights from those who fund science, or even from the scientists themselves. In matters of public importance, such as climate change, the acquisition of IP should be minimized.

In considering the performance of the above-mentioned types of information network, and the role of different institutions, we must remember that underlying their policies is the power of their constituents – shareholders in the case of quoted corporations, and voters in the case of democratic governments. Public institutions are not in themselves to blame for poor outcomes. Their leaders, certainly, are in a position to exercise some influence, but ultimately it comes down to the ballot box; so an enormously important task is to inform and persuade citizens everywhere of the need for strategic change. Personal changes in carbon footprint have become quite popular in developed countries, and should be supported further, through initiatives such as the Product Carbon Footprint project conceived at the Potsdam Institute. However, of themselves personal changes achieve little. They need to be complemented and framed by strong and pro-active government climate policies. Citizens play a crucial role and must be convinced of the need to vote for strategic change.

Incentives and licensing mechanisms

In order to be realistic, economic models need to embrace the concept of dual reward rather than focussing solely on financial incentives. Depending on individual inclination and circumstances, scientists may seek one or both of the following reward mechanisms:

- Personal attribution. This is supplied by ordinary scientific publication, and, if properly set up, by attribution to databases. Personal evaluation by peers is of considerable importance as well, and can be reliable in tight-knit communities, but is capricious and susceptible to misuse on the larger scale. Therefore, scientists are entitled to expect some formal attribution to further their careers, and indeed we cannot expect efficiency unless those who are most effective are recognized as such.
- Financial reward. Scientists differ greatly in their requirements for financial reward. Most are chiefly rewarded by the chance to perform valuable scientific research, by success in their research objectives, and by the benefit to society that results from their efforts. However, some are additionally motivated by the possibility of rich returns from licensing their discoveries for profitable development.

Those who fund science may similarly be driven by a mixture of motives. They will seek a successful outcome in any case, but if the resources are derived from investment then profit is required as well. In the field of climate change, as in medicine, the awarding of prizes for successful innovation is being tested; proponents of this type of incentive point to historically successful prize systems, such as in navigation and flight.

In order to grant recognition and financial reward equitably a range of licensing arrangements has been devised. Here are some examples, ordered from most free to most restrictive:

Free release. This arrangement is the norm for non-commercial work. It was employed on a large scale by the Human Genome Project. It is the right model for fundamental information about the natural world.

General public licence (GPL). This arrangement was devised by Richard Stallman at the Free Software Foundation. By acquiring, using and modifying software under a GPL, the user agrees to make the source code available so that others can do the same. There is not – as commonly thought – any prohibition on fees, which explains why the commercial use of GPL software is increasing.

Conditional open access. A wide variety of licenses is being devised, with varying constraints, for example the demand for fees from high-income countries and their waiver for low-income countries. The non-profit corporation Creative Commons[2] provides analogous licenses for the mitigation of copyright.

Exclusive rights patents and copyright. These instruments form the backbone of our present IP system, which is essential to the global economy as currently organized. However it is widely accepted that the system is not working optimally, though powerful vested interests resist change. At times debates seem quite ideological, with any attempt at rational discussion drawing accusations of weakening the system on which our wealth depends. Ways forward are being debated at the World Intellectual Property Organisation (WIPO), as discussed in the next section.

[2] http://creativecommons.org

Some problems for benefit sharing

- Excessive desire for personal attribution
- Perceived loss of incentive if IP is not retained
- Focus on short-term profit
- Exclusive patent rights as revenue source, leading to blockages
- Government perceptions and requirements, securing IP regardless of efficacy
- Competition for international trade, excessive IP requirements in trade agreements
- Inequality, leading to imbalance in negotiating power, including legal representation
- Unforeseen consequences of the free market
- Excessive reliance on 'corporate responsibility', which, on account of bottom line effect on share price, can make only a negligible contribution
- Digital rights management, which with modern electronic implementation is eliminating traditional 'fair use'.

Elements of trust

As we have seen, our global game of prisoner's dilemma can only move forward through increasing trust between the participants. What are the important aspects of that process?

Benefit sharing

Benefit sharing is a key element of trust. It is particularly important in a world where wealth is very unevenly divided, because in the absence of such proactive measures benefits will be unevenly divided as well, and will continue to drive a vicious circle of deprivation and mistrust. A recent example of such failure was Indonesia's quite understandable objection to providing its avian flu samples (the sharing of which is important to all of us) to the World Health Organisation (WHO) until safeguards were in place to ensure that Indonesia would share in vaccines that might be derived from the samples (Indonesia had observed that earlier samples had gone into the profitable activities of US and Australian corporations, whence the products were sold at prices that were unaffordable for developing countries.) Such an outcome is extremely destructive, because prediction of future epidemics, and the development of drugs and vaccines that may mitigate them, depend crucially on sharing knowledge of novel virus strains as they arise. The WHO should ensure that all countries, not just the most industrialized, benefit from sharing, thereby

balancing openness with opportunity. But at the moment it is unable to do so, as it is constrained by the financial interests of its major contributors and transnational corporations.

Sharing of goods and services is carried out through the world trading system. In order for the sharing process to be equitable, we need to ensure that trade rules are equitable. A big step in the opposite direction was taken by the TRIPS (trade-related intellectual property rights) Agreement in 1995. This laid down a timetable for all nations, rich and poor, who wish to be members of the World Trade Organisation (WTO) to adopt stringent rules on IP. Since membership is important for access to markets, there is great pressure to sign up. Many developing nations adopted the rule, including, for example, India in 2005, and only the least developed nations remain outside. There is a strong sense that developed countries are pulling up the ladder: when they were in the same position as developing countries are in today they paid little attention to one another's IP rights. China has benefited greatly by ignoring the WTO throughout its recent growth period, and now joins from a position of strength.

It is important for the provision of healthcare as well as fair trade that there is flexibility within the TRIPS Agreement. Some key steps in that direction were taken in the Doha Agreement of 2001. The measures do not work very well, but in principle (through compulsory licensing) allow developing nations to avoid paying high prices for medicines.[3] Further steps have been taken by the adoption of a 'development agenda' at the WIPO, and by discussions at the WHO following the far-sighted report of the Commission on Intellectual Property Rights, Innovation and Public Health chaired by the former Swiss President Ruth Dreifuss.

The Indonesian experience over avian flu highlights the problem of 'biopiracy', in which novel genetic resources are appropriated for gain by the economically powerful. In some cases (notorious examples include the neem tree and basmati rice), centuries-old prior art[4] has been ignored by patent examiners in wealthy countries, on the grounds that it is not formally documented. Unwillingness to confront this injustice is a major obstacle to achieving a harmonized world IP system. Under the Convention on Biological Diversity, rules for benefit sharing of genetic resources are being constructed, but progress is slow because of lobbying by vested interests in the wealthy countries.

Multinational agreements are the best way to achieve benefit sharing, but only if they are honestly negotiated and fully respected. The problem is that they are not. Seeing signs of democratization of the trading rules, OECD countries (the

[3] One practical problem is that developed countries are liable to retaliate with trade sanctions if a developing country uses compulsory licensing, as has happened recently in the case of Thailand. Another is that for countries lacking their own manufacturing capability, the measures are prohibitively cumbersome.

[4] This term is used when previously existing knowledge bars a patent.

USA in particular with the EU as an eager supporter) have been attempting with some success to negotiate bilateral agreements with individual developing countries and to set up so-called 'free-trade areas'. The incentive in such arrangements is the granting of enhanced access to rich markets; the drawback is that usually there is an insistence on 'TRIPS+' standards of IP, in which much of the flexibility is removed. The existence of a meshwork of special agreements weakens the multilateral structure on which trade should be built. At present, we are moving towards trade that is neither free nor fair, but which rather smacks of imperialism. There are ominous echoes of the network of alliances that preceded the First World War. In order to deal with global problems, including climate change, there is a need to halt the trend towards bilateral agreements.

Unequal benefit sharing is increasing the gap between rich and poor in many ways. One very serious consequence is that opportunities for personal progress are diminished in the developing countries, with a consequent increase of legal and illegal migration. The 'brain drain' of the most talented individuals is of course particularly damaging to a country, and attempts to reverse that by investment in education, research and industry are very desirable (see Hassan, this volume). It is also vital that personal attribution is attainable in less well-endowed scientific institutes. Economists often equate incentives with financial reward, but scientists are motivated at least as much by the personal excitement of discovery and invention, and will tend to prefer working where they have both adequate resources for research and the ease of recognition that comes from being in the mainstream.

Access to knowledge

It is fashionable in the rich countries to refer to modern society as the 'knowledge society'. Whether that is accurate or not, it is a fact that enclosure and protection of knowledge is epidemic: the scope of IP is being continuously extended, and more stringent means to prevent its unauthorized use are being introduced. We have already looked at some mitigating measures that are being taken in the area of publication. We must recognize that these measures and the transfer of technological expertise are a necessary part of developing trust. Access to knowledge is one of the most important rights for developing economies.

Easy access to knowledge is important for individuals as well as institutions, in rich as well as poor countries, and this aspect is considered by Susanne Kadner (this volume).

Integrity

Another aspect of trust has to do with confidence in the accuracy and completeness of shared information. Science is self-checking, in that results are constantly queried and elaborated upon, so that errors eventually come to light. But this takes time. In the short term, accuracy of scientific information depends on the integrity of scientists, backed by peer review of publications. Apart from the inevitable errors, recent studies have revealed a steady trickle of falsified results, and occasionally a major scandal hits the headlines. It must be said that these cases represent a tiny fraction of overall scientific effort, and in view of the greatly increased number of scientists working today this fraction is probably not increasing. Nevertheless, concern about the accuracy of scientific research in a global setting is leading to the establishment of more monitoring systems to discourage misconduct. This is just as well, because in a newsworthy field such as climate change there is a great deal of commentary at very varied levels of professionalism. It is important for people to have access to sources of information that are not only open but also trustworthy.

Integrity is even more important at an institutional level than it is for individuals. Regrettably, systematic disinformation is characteristic of the lobbying and advertising industries, and, to varying degrees, of the political process. As an example of the former, the tobacco industry has for decades invested heavily in denying the link between smoking and lung cancer. While its activities have been greatly restricted in wealthy societies, it is now unashamedly peddling its wares among the poor. A prominent example of disinformation from political sources was the denial by the Mbeki government in South Africa that HIV caused AIDS. Corporate misbehaviour creates numerous impediments to tackling climate change. For example, the oil industry has funded objections to the identification of human activity as a primary cause, far beyond the point of balanced debate; the producers of bottled water lobby against the use of tap water; manufacturers of baby formula encourage mothers not to breast-feed their infants; and the food industry encourages overconsumption, resulting in increased obesity as societies become wealthier.

Sharing of natural resources

A key element of benefit sharing is the equitable division of natural resources. Mostly it is left to the rather primitive mechanisms that we have just touched on. We need to do better than that if we are to deal with sharing of water, food, and the Earth itself without conflicts even more destructive than we have at present.

A striking example of failed benefit sharing is our collective inability to prevent the fishing industry destroying fish stocks, and therefore its own livelihood. Information flow is a vital step in sharing resources. But whereas information can be

shared indefinitely without loss to anyone – indeed with gain as value is added to it – natural resources are consumed. We may divide the fish as equitably as we please, but if we collectively take them out of the sea faster than they can reproduce we are in the end left with nothing. Despite adequate information, understanding and communication, fishery after fishery has collapsed. Perhaps the most spectacular crash to date is that of the Grand Banks, largely under Canadian jurisdiction, in the early Nineties; it has not recovered. In Europe we are struggling with the declining North Sea fishery, once enormously rich and now a fraction of its former size. Modern technology saves effort and makes fishing safer, but it cannot solve this prisoner's dilemma for us any more than science and technology will of themselves solve the problem of climate change. Establishing sustainable fisheries is a model exercise for the EU. If we can solve this socio-economic problem, perhaps we shall find the mechanism to tackle climate change.

The nature of the problem becomes apparent when we contrast the above situations with one fishery that has probably been made sustainable. In the Seventies Iceland confronted the UK and Germany in order to establish the right to control its coastal waters (the so-called 'cod wars'), and then set up legal constraints to preserve the fish stocks. Here a small country with much to lose has achieved what countries such as the UK and Spain, let alone the EU as a whole, have so far been unable to do. Trust comes more easily to the small group; we have to find ways to foster it in the global group.

Underlying all the problems in the sharing of natural resources (including the Earth's atmosphere) is the issue of excessive human population, which is seldom discussed explicitly because it is so contentious. A detailed discussion is beyond the scope of this essay, but the issue is touched upon by Wolfgang Lucht and Walter Kohn in this volume. Here I would simply note that, in some way or another, we must start assessing the issue of population coolly, morally and humanely. Otherwise all our other efforts will be in vain.

Conclusion

Large-scale manipulation of climate, even assuming that we have the technology and expertise to do so, can only be carried out in an atmosphere of transparency and trust. The hyper-competitive stance that has been the norm in international relations, while effective for short-term gains and understandably driven by the demands of the ballot box, will be disastrous for the problems that now face us. For the free flow and effective use of scientific information, we need to put in place settlements that are agreed by rational negotiation rather than by power struggles. In short, if we are to make progress, the globalisation of trade must be accompanied by the globalisation of justice.