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The future of the nexus between science, society and governments: a survey of issues and their implications for the science community

I am honored to present an opening address at this most important meeting. Over the last few years I have admired the reflective way the Japanese science and policy communities have contemplated the complex interactions between science and society – your discussions have much to teach us. You have been willing to think about the role of science in diplomacy and global relationships, particularly through the annual meeting of the STS forum in Kyoto, you have been open to learn lessons from the tragic disaster of Fukushima as reflected in the revised code of ethics of the Japanese Council of Science and you have been leaders in confronting issues in the integrity of science through contributions to the OECD and the international Council of Science. And I must particularly acknowledge the contribution of Dr Arimoto and Dr Yuko Harayama and their respective colleagues to the ongoing discourse of the relationship between science and society. I have had the benefit of their counsel on a number of occasions.

The Science Agora is a highly innovative event – one that brings many stakeholders together. This large range of stakeholders demonstrates the central fact that science and technology are essential to a healthy future irrespective of whether we look at it from the perspective of the planet as a whole or as individuals, or whether we look at it from the perspective of nation states or as cities or communities, or whether we look at it as a global community facing numerous shared challenges and opportunities. We collectively face the many common challenges – climate change, natural disasters, pandemics (and Ebola is giving us a timely reminder of how interconnected we all are), water and food insecurity, and of using cyberspace for advantage and not for catalysing crime and terrorism; We all recognise that science and technology are key to addressing such challenges. But we also see the many opportunities for economic growth, a better environment and healthier societies

based on innovation, better use of data and social and other sciences - science and technology are indeed key to all our futures.

But we must acknowledge that science and technology have also contributed to the very problems that we now confront: progressive technological developments over the past 200 years have fueled the rise in CO2 emissions, multiple technologies have led to the explosive rise in human populations on this planet which in turn have had so many consequences. And as new technologies evolve so do the societal questions and ethical challenges that we must confront: what is the future of the internet of things, of bio-implants, of the sense of privacy in a cyber-driven world, of synthetic biology, do we need geo-engineering, how do we ensure everyone benefits from the progress of science and so forth.

And as science has evolved, the knowledge that arises and the technology that emerges increasingly impacts on society – not only on the use of it but also on how society perceives both science and the choices and trade-offs it creates. These perceptions determine whether society will accept a technology or not. Scientists can no longer assume society will accept what science has to offer – we have seen this in the societal debates over genetic modification, nuclear power, and stem cell biology. We have learnt in each of these and many other cases that social license for a technology does not emerge just because scientists proclaim that it should.

And we have seen in the inexcusably slow acceptance of anthropogenic causes of climate change that neither the public nor the politician will automatically accept science as an instruction to act.

And we need to appreciate why. Science does not have all the answers; science cannot address issues that are primarily social values based. Science can provide knowledge that can inform discussion in such matters by elucidating the likely implications of one course of action over another. But it cannot give values laden weight to these options and thus resolve values based debates.

And it is these values-based issues, informed by science, that make the relationship between science and society so complex and are why we cannot take social license for a technology for granted. Rather, it is obtained, withheld or revoked on the basis of TRUST. Science relies on trust to maintain its somewhat privileged place among epistemologies: both trust within the science community and trust of the public about the integrity of its methods. But trust in science can erode in many ways.

Too often we overstate what we know and understate what we don't know. And when contentious issues are made more difficult by scientific uncertainty and

complexity, there is a danger of advocating for or claiming a simple answer when the answer is multifactorial. All of this can undermine trust in the scientific enterprise.

And trust is also undermined when scientific integrity is compromised in more deliberate ways. Scientific fraud is more common than we sometimes acknowledge and we are still learning about its root causes (whether they are systemic – in the generalized race to publish for instance - or individual) and how to address these. We are seeing more vigilance about scientific reproducibility and transparency of data.

Taken together, the changes to the science landscape have resulted, in part, in more mission led science, for more collaborative science and a shift away from publication as a primary index, toward priority and impact. How this will evolve is unclear but society will demand more from the scientific community in ensuring integrity and confidence in scientific claims.

To be built and maintained, trust relies on good communication. But traditionally, scientists have been ill-practiced and rather poor at communication with the public and the governments that represent them – especially when the issues appear complex and uncertain. In a recent national survey in New Zealand, 48% of respondents said science was too complex to be understood. Worse, 51% said that scientific information seems rather conflicted so it is difficult to know what to believe. We have a great challenge in science communication particularly in areas where social license is needed if society is to properly engage in defining the use and limits of science and technology. Too often an underlying scientific consensus is blurred by overrated points of academic debate that are driven by opportunities for publication and profile.

Scientists need to be aware of the potential impacts of their behavior and communication and we need to reflect more on it, as indeed has Japan following the Fukushima tragedy. I applaud the Japanese Council of Science for its revised code of ethics that brings these issues into sharp focus for the science and policy communities, and in doing so helps enhance public trust.

Your revised code points out the need for scientists to be more engaged with the public on one hand, but it also makes clear the need to do so in a way that reflects on the power and influence of science communication on the other. It is no accident that this issue has come into sharp focus after several major natural disasters where scientific advice was found to be misleading and indeed harmful. And this is difficult territory because we all acknowledge both academic freedom and the freedom of speech. But if we are to argue for the unique and privileged role of science in

informing policy – because it is the only way to gather reliable knowledge of our world and ourselves – then society must trust that science is self-correcting, that it can recognize and mitigate inherent biases, and it can maintain integrity. How we as scientists communicate with each other and with the public can impact on that trust. If that trust is broken, science will not be able to fulfill its role in assisting the world to a better place. Again I thank the Japanese scientific community for its willingness to consider a number of these issues.

Allow me to make three other brief comments about what I suspect may be recurring themes over the next two days – given that every advanced economy is grappling with similar issues.

As governments spend more on research and development, the inevitable outcome has been that governments and taxpayers wish to see evidence that that investment has been impactful. Impact is often thought of in purely direct economic terms – and of course a major reason for national investment in R&D is for science based-innovation reflected in increased exports of products and knowledge-based services.

But the impact agenda is much broader. Soon a report will be released by a consortium of six small advanced economies that I chair (NZ, Singapore, Ireland, Finland, Denmark and Ireland), which suggests a broader taxonomy of impact. We must remember that much science has indirect effects on the economy and health of nations through production of a trained workforce, through impacts on environmental science, health, social science to inform better public expenditure, through preparedness research such as bioprotection, seismology and public health research. And the foundational role of discovery science as being key to all that follows must be remembered – a point well understood in Japan where the increasing number of Nobel laureates is a direct manifestation of the importance placed on discovery science.

And as science plays an increasingly important role in developing and sustaining trade relationships, in foreign aid and in addressing the major global challenges, science and diplomacy have become intimately engaged. No advanced country can do it all on its own and international collaboration is now a key part of the science playbook. But the world does need to find ways to better use science to address international issues and I will expand on this this afternoon.

Allow me to make a few comments about the critical nexus between government and the science community. This was the subject of a major meeting in Auckland, New Zealand earlier this year, the first global meeting on science advice to governments. What was clear from that meeting of 230 experts from 46 countries is

that the importance of this nexus is being increasingly explored. The issues of how to create effective means of scientific advice and to promote its utility to policy makers were discussed at length. Given the many different cultures and political systems present, it was surprising that consensus was reached. For instance, it was repeatedly noted that the business of science advice requires particular skills to bridge the cultures of science and policy-making and that both scientific and policy hubris can impair that transition.

It also was acknowledged that science rarely alone makes policy and that science can inform policy making but in the end it is values based domains such as political philosophy, public opinion and fiscal considerations that largely determine the choice of policy options. The key is to develop systems that ensure that relevant scientific knowledge is maintained across the policy process at each step. This is not easy. Again the issues of trust and integrity were emphasised as core to effective science advice.

The issues of science advice to inform policies broadly were seen to be generally distinct from those of advice to develop and inform the science system *per se* and often involved differing but overlapping structures and people.

Science advice could be seen to have three principle manifestations; the structures needed for each differ and a complete system needs an appropriate mix of all three. First formal advice through academies and panels works off a long time base and for subjects that need a deliberative approach. Secondly informal advice through individuals embedded close to government is necessary to help where governments need a near instant response, set the questions right in the first place and to ensure science does not get corrupted within the policy formation process. Thirdly there is the issue of advice to governments in crises or emergencies when science advising becomes, of necessity, part of the decision making process. The role of individual advisors in these last two classes of function is increasingly recognised while that of academies and panels is key to the former.

Finally let me point out that the changed relationship between science and society is driving disruptive changes in the science system that is also being impacted by many internal changes. There are many contributing factors – just to name the most obvious:

The democratisation of science as it shifts from a patronising relationship with society to a true compact will mean that society has a greater say in what science is done and what science is used. As a result there is a growing sense that science must demonstrate its utilitarian value. In turn this is leading governments to be more

explicit in prioritising how they wish the science investment to be made. Science itself is becoming truly inter-disciplinary and being done in larger teams. The move to open access data and the growing capacities in big data are fundamentally changing the opportunities for and the types of research undertaken.

And the output side of science is changing with the changed nature of science publication, leading to problems in the assessment of science performance, and the development of alternate means of science communication.

The peer review system is internationally under pressure from the expansion of tertiary education-associated science. Peer review has been the mainstay of quality assurance in science but it is a large but hidden cost on the science system. The way peer review is conducted will change and the focus must be on finding and using systems that ensure quality and integrity. And as we have discussed the greater transparency in science is exposing a lack of professionalism in science, and in particular issues of research integrity. A particular issue has been the poor reproducibility of much science driven by the rush to publish, the academic impact agenda and the personal stakes now associated with 'breakthrough science'.

The science community, being inherently conservative, may struggle over the next decade as it adapts to greater societal expectations and involvement, but in responding science will truly become embedded as a social endeavor and only then will society achieve maximal benefit from what science can offer.

Once again I congratulate the Japanese Science and Technology Agency and all those involved in creating an Agora - that is a gathering place - for ideas. The many different perspectives here in this room allow for an exciting dialogue that must advance the interests of all stakeholders both in Japan and around the world.

Thank you for the privilege of being here.