WORKSHOP REPORT

Convergence of Disciplines

BRUSSELS, 18 AND 19 SEPTEMBER 2014

SCIENCE EUROPE
Physical, Chemical and Mathematical Sciences Committee

Physical, Chemical and Mathematical Sciences Committee Workshop on Convergence of Disciplines

BRUSSELS, 18 AND 19 SEPTEMBER 2014

This workshop was convened by the Science Europe Scientific Committee for Physical, Chemical, and Mathematical Sciences to explore issues surrounding the concept of 'convergence' and its potential relevance to, and implications for, research funding organisations and research performing organisations in Europe. The aim of this exploratory workshop was to provide a forum for debate and discussion, rather than to arrive at specific conclusions or formulate policy recommendations.

The workshop, attended by some 45 delegates, took the following format: four keynote speakers with expertise relevant to the topic of convergence gave presentations, followed by three short interventions. Delegates were then split into three groups which sat in parallel to explore the areas of governance, tools and infrastructures, and training and careers. Again this was followed by an open discussion.

Summary

- Convergence can play a central role in addressing many key questions across science, technology and society by bringing together researchers from different disciplines, including the humanities and social sciences, to work towards a common vision, a common goal, and/or a global challenge. Convergence is then to be seen as a governance tool.

- Convergence is not restricted to applied research questions but rather to 'purpose-driven' research, which includes basic research.

- Convergence can be both driven from the bottom up, by individual researchers or research groups, and from the top down, by strategic programming.

- As a governance tool, convergence requires structures for management necessary for the success of a convergent approach. Structures need to be implemented at different levels (funding, research activities, and so forth).

- It is likely that a programme of convergence will require longer-term funding than for conventional discipline-based research programmes.

- The evaluation and assessment of proposals for convergence research and of outcomes of such programmes will require broadly based, cross-disciplinary panels and a different approach to assessment and evaluation than a traditional discipline-based approach.

- Researchers should not be penalised for working in a convergent environment because they may not be able to publish in traditional discipline-based journals, which, in turn, could have implications for promotion and career advancement.

- The establishment of convergent 'ecosystems' or 'safe havens' may be a way to address this issue.

Keynote Presentations and Interventions: General Overview

Convergence is not necessarily a simple concept to grasp. Convergence of Technology, Knowledge and Society (CTKS), as formulated by US researchers,[1,2] is as follows:

> "Convergence is the escalating and transformative interaction among seemingly distinct scientific disciplines, technologies, communities, and domains of human activity to achieve mutual compatibility, synergism, and integration, and through this process to create added value and branch out into emerging areas to meet shared goals."

In this sense it is far broader, more complex and wide-ranging than simply the notion of 'interdisciplinarity'. Many times it was stated in the meeting that 'convergence is not interdisciplinarity'. Nonetheless, it was notable that even in the final discussions of the workshop many delegates referred to 'convergence/interdisciplinarity'.

In many fields, convergence has arisen and evolved more or less spontaneously, such as in nanotechnology and cognitive science, where many disciplines have coalesced under a single umbrella with a shared goal. An example of the benefits of convergence is in gene sequencing, where biology converged with the semiconductor industry to result in technologies that brought about a dramatic rise in the speed and fall in the cost of sequencing. Other examples suggested during the workshop include the Human Brain Project, the challenge of food security, and the issue of 'sustainability'.

One of the key questions is whether it is possible to institute policies and structures to accelerate convergence where it is seen as desirable and in the interests of wider society. This opens up the issue of control and, indeed, political influence. However, Mike Roco, Senior Advisor for Nanotechnology at the National Science Foundation (NSF) and a leading thinker in the field of convergence, told the workshop that "convergence is not governing from the top down; rather it is creating a new goal, new methods, new processes to develop and understand things. It is a model of governance and not of government." It is worth noting that the Organisation for Economic Co-operation and Development (OECD), which produced a report in 2008 (http://www.oecd.org/sti/broadband/40869934.pdf), recently decided to create a committee on convergence.

South Korea has embraced the concept of convergence with enthusiasm, with a centrally co-ordinated national strategy to direct convergence between research performing organisations and industry. In 2008 the government established its first national development plan for convergent technologies, and this policy has continued. Seok-Jin Yoon, director of convergence research at the National Research Council of Science and Technology, told the meeting that the aim of the initiative

is to create “a new growth engine and enhance competitiveness” for the country. Much of the effort is focused on addressing issues of national importance, such as the ageing society, energy and environment, and urbanisation.

Within Europe, however, the explicit idea of ‘convergence’ as a defined concept in its own right appears to have dropped off the radar somewhat over recent years. As far back as 2004 a high-level expert group produced a report on ‘Converging Technologies for the European Knowledge Society’ (CTEKS) for the European Commission.

The term was used by the European Commission in the Seventh Framework Programme, but hardly appears in the documentation for Horizon 2020. Nevertheless, there is a focus on cross-fertilisation and interaction between different fields to tackle the defined ‘grand challenges’, and in this respect the notion of convergence is present, albeit not defined as such. “When we look at the objectives of convergence and at our objectives, they are pretty similar”, said Jyrki Suominen, Deputy Head of Unit for Advanced Materials and Nanotechnologies in the Key Enabling Technologies Directorate of the European Commission’s Research and Innovation Directorate-General. “We have concluded that Horizon 2020 is an excellent example of convergence even though it is not specifically mentioned.”

Alfred Nordmann, rapporteur of the 2004 CTEKS report, said that “the concept has in some sense disappeared as a specific label in Europe, and in the US there is no large scale funding agenda.” On the other hand, however, “there have been hundreds of papers written on NBIC (Nano-Bio-Info-Cognitive) convergence [and] examples of this type of process are becoming commonplace whether you call it convergence or not.”

The common goal, said Professor Nordmann, “does not just happen through top-down planning, but through an agenda-setting process; a problem-oriented attempt to match knowledge and capabilities with society’s needs.”

For Thomas Sinkjaer, Director of the Danish National Research Foundation, funding organisations face a number of challenges in attempting to instil a culture of convergence among researchers: “For the last 20 years we have had centres of excellence where we have looked to bring together different disciplines, but there is a challenge to arrive at the optimal constitution of these centres; they can end up with too few people and be too narrow or else too many and too broad.” One possibility to encourage convergence could be to give the funding to a single visionary research leader to provide strong cohesiveness. “We need to think about our organisations in a different way to the classical setting”, said Sinkjaer. “It is difficult to get traditional discipline-based assessment processes to understand the importance of projects that are done in a wider context. There needs to be collective agreement and you need a follow-up system where these centres can be continuously challenged: are they doing the job you want them to do? Not on the science *per se*, necessarily, but on the way they approach science.”

Igor Emri, Chair of the Science Europe Scientific Committee for Engineering Sciences, pointed out that convergence is inherent in engineering, an example being the convergence needed for the development of devices such as mobile telephones and motor cars. “An appropriate socioeconomic platform is needed to enable the interaction of technology with humans and society to elaborate such technology,” he said. He also raised the question of possible threats posed by a convergent approach.

Thomas Kaiserfeld, a member of the Science Europe Scientific Committee for the Humanities, asked the question, “Are research systems in Europe adequately organised to promote convergence technologies?”, to which he himself responded, “From the perspective of the humanities the answer is a resounding, ‘No’”. Professor Kaiserfeld suggested that “European research is heavily biased towards some areas and not others. The humanities and social sciences must be recognised as equal partners in our common struggle to achieve high quality research that is relevant to all of us. As long as the humanities and social sciences remain effectively locked out from formulating policies, convergence will remain a research policy dream, and in fact probably a nightmare for people forced to line up researchers from different disciplines to make proposals comply with the demand for convergence.”

Breakout Group Discussions

The following sections summarise the key points from the three breakout group discussions:

Governance: Between Bottom-up Research and Top-down Visions

- A distinction should be made between curiosity-driven research and purpose-driven research. While the latter can include applied research or research in response to a particular issue faced by society, it can also include fundamental, basic knowledge-generating research. In this regard, while curiosity-driven research may not be amenable to the concept of convergence, purpose-driven research may be. Purpose-driven research can be ‘bottom-up’, that is the research agenda is driven by the individual researcher(s), rather than ‘top-down’ research which is driven by some overarching agency such as a research council. There can sometimes be a wrong perception among researchers of purpose-driven research, and this can lead to reluctance to participate.

- There is a worry that widespread adoption of convergence could result in the polarisation of research, with winners and losers emerging from such a system. Research performers might need time to adapt to this new way to govern research through goal or challenge-driven programmes.

- There are issues of scale, particularly in relation to addressing the ‘grand challenges’ facing society, such as climate change and the shifting demographic. Is there sufficient capacity at the national, regional or European level to undertake these big work programmes? In that respect, there needs to be more compatibility between national programmes at the European level to tackle the grand challenges and this needs better communication channels.

- There is a need for researchers to be able to think broadly, beyond the strict boundaries of their own tight discipline, if convergence is to be supported and implemented. This has implications for education, training and careers.

- Under a system that is nudging people towards convergence, there needs to be the appropriate framework and rules for the evaluation and assessment of proposals. If excellence is an important criterion for evaluation, additional criteria need to be developed and taken into account in these procedures both for ex-ante and ex-post evaluations.

- In addition, it is clear that convergence requires time, and this in turn will need longer-term funding than for many traditional research proposals.

- There should also be an understanding that negative research results do not constitute 'failure', rather they add to the sum of knowledge and are a valid outcome of research.

- In conclusion, there appears to be a consensus that things are moving towards the direction of greater convergence and that governance will be needed to facilitate this; a 'light touch' would be the better approach, rather than a 'heavy hand'.

Tools and Infrastructures

- Physical infrastructures can represent an opportunity for researchers from different fields to converge. CERN (the European Organization for Nuclear Research), for example, goes beyond particle physicists and converges with other communities such as information and communication technologies (ICT). On the other hand, however, there is often an element of 'ownership' of infrastructures, and one community may be seen merely to be 'borrowing the tool' of another. Clearly this is not an example of convergence.

- Networks are important. Bioinformatics, for example, was driven by the need for biologists to use informatics to solve systems biology problems. In general it is easier to create networks to collaborate around a convergence topic at a high level rather than at the level of individual labs.

- Some countries in Europe do have systems to encourage the creation or the fusion of research communities to address particular issues. So-called 'sandpit' or 'ideas lab' approaches have proved effective, where researchers from different fields are brought together for intensive discussions on potential ways to pool their intellectual resources and expertise to tackle specific problems.

- Funding schemes are central to the realisation of convergence, and while there is a recognition that top-down funding will form a key element, it is important that bottom-up funding also plays a significant part and the two should work in tandem. What would not be a good idea is to attempt to force communities to converge in a contrived or artificial way. This would invite failure.

- Evaluation is vital and challenging. Conventional evaluation panels are inherently disciplinary in nature. For evaluation of convergence proposals, a diversity in panel membership will be necessary. Any evaluation must consider how likely the proposal is to meet the scientific and societal goals. But this must not be at the expense of eroding strong disciplinary research. It is also important to recognise that convergence is happening, even if it is not be defined as such. Such examples should be built upon. In some countries the chair of the evaluation panel does not represent a specific research field but rather comes from a multidisciplinary environment (such as from industry) to work as a 'mediator' between different fields.

- One approach to evaluation can be essentially Darwinian: where a centre that is established to carry out convergent research is sustainable, if, after a period of time, it can stand on its own feet and bring in its own funding, it can by definition be described as successful.

Training and Careers

- Moves towards convergence bring opportunities but also risks, so any strategic approach towards introducing greater convergence must exploit the former while reducing the latter.

- By and large the research culture in Europe does not lend itself to 'systems research'. For convergence to work successfully, a culture must develop whereby carrying out integrated research is not seen as somehow inferior to tight, discipline-based research. That said, it will still be necessary to ensure that there is a pool of specialist talent, of people who do work within a discipline to achieve high levels of knowledge and expertise within that specialism.

- By the same token, publishing is done within disciplinary boundaries and working in a convergent environment might make publishing difficult. In our current system, this in turn impacts upon an individual's prospects for advancement and promotion. When people do work in interdisciplinary teams, the individual members then often publish separately in their 'own' journals, reinforcing the divisions of disciplinarity.

- The concept of convergence has implications for educating young researchers and would-be researchers. Undergraduate education in Europe is largely disciplinary.

- One concept that could be considered is to work towards developing 'ecosystems' to allow convergence to flourish: a safe haven of convergence as it were, with appropriate and parallel training of students, teachers and evaluators. Existing examples might provide a template, such as the European Molecular Biology Laboratory (EMBL) Interdisciplinary Postdoc (EIPOD) initiative. What remains missing, however, is a means for capacity-building in terms of training people and nurturing a sustainable culture of convergence. Again, there would also need to be a sound mechanism for evaluating outputs of such ecosystems. Traditional reliance on output metrics such as publication may not be appropriate for such systems. Moreover, the development of such ecosystems will require some kind of management and structure, but in a way that does not constrain the fluidity and dynamic evolution of the system. Convergence is inherently dynamic and, because of this, structural 'straitjackets' must be avoided.

- In order to foster the emergence of convergence and ecosystems, the European national research councils should dedicate financial resources to training students, teachers and evaluators adequately to meet the emerging needs and new approaches. The training schemes need to include the development of research skills, new teaching methods and research proposal assessment schemes. These efforts should be followed by the development of career plans adjusted to individuals that conduct scientific research requiring integration of knowledge from various disciplines. The existing European funding schemes, such as Marie Skłodowska-

- Curie Actions and European Research Council (ERC) grants, should provide financial resources to facilitate the development of adequate research skills. Moreover, the Horizon 2020 calls for proposals need to contain dedicated funds for training individual researchers in the ability to integrate knowledge appropriately within converging disciplines or topics included in the Horizon 2020 work programmes.

Conclusion

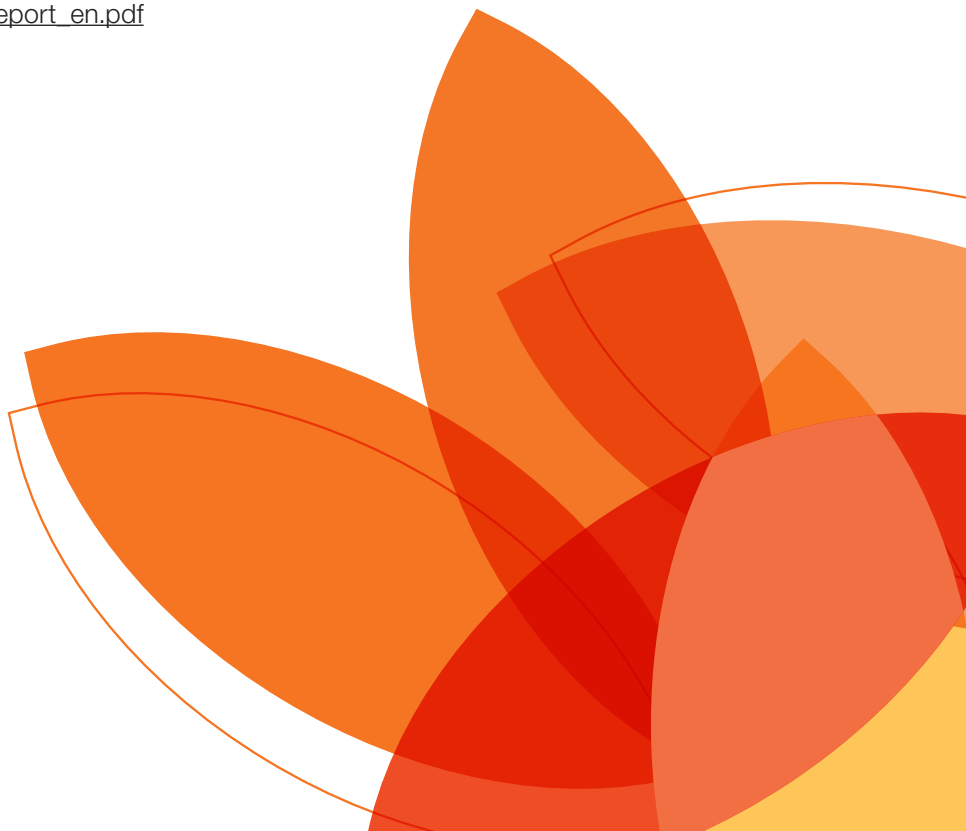
There was agreement among the workshop participants that the way in which research is currently organised is evolving and that the concept of convergence – or the concepts of goal-driven or challenge-driven research – is playing a key role in this evolution. This is linked to the idea of creating new knowledge by blending and fusing different fields, technologies and environments to solve key issues. The question remains of how to best organise the research systems to facilitate this evolution.

The discussions demonstrated that there is currently a lack of awareness of what other organisations are implementing to meet this evolution (for example national institutes, participation in Joint Programming Initiatives, centres of excellence, and so forth). In some countries it seems that there is only a light touch on convergence as it is not considered to be an issue, or because it is assumed that it is something that will arise naturally. However, it was also suggested that it may be too early to evaluate potential successes of examples of convergence (in different countries or in different fields) and that comparisons between countries (with different cultures) that are applying convergence should be made, in order to learn from these experiences.

[1] Converging Technologies for Improving Human Performance – Nanotechnology, Biotechnology, Information Technology and Cognitive Science', M.C. Roco, W.S. Bainbridge, Springer, 2003. http://www.wtec.org/ConvergingTechnologies/Report/NBIC_report.pdf

[2] Convergence of Knowledge, Technology, and Society: Beyond Convergence of Nano-Bio-Info-Cognitive Technologies', M.C. Roco, W.S. Bainbridge, B. Tonn, G. Whitesides, Springer, 2013. http://www.wtec.org/NBIC2-Report/

[3] Converging Technologies –Shaping the Future of European Societies', 2004. http://www.ntnu.no/2020/final_report_en.pdf



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

More information on its mission and activities is provided at: www.scienceeurope.org.

To contact Science Europe, email office@scienceeurope.org.

SCIENCE EUROPE
Shaping the future of research

Science Europe
Rue de la Science 14
1040 Brussels
Belgium

Tel +32 (0)2 226 03 00
Fax + 32 (0)2 226 03 01
office@scienceeurope.org
www.scienceeurope.org