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Comment

THE SOCIALISATION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

Social technologies and socialization of research

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ABSTRACT: Whether we like it or not, and how many difficulties this may pose, scientific research and technology are becoming the "property" of everybody and increasingly will become subject of public guidance and political decision making. Socialization happens because what people think, want and do has become central to the development of science and technology. Socialization of research is simply happening because it is the development characteristic of a society in which knowledge is becoming the main driving force. And just like in agricultural or industrial societies in the past it leads to (re-)invent the institutions and mechanisms which allow the knowledge society to function properly.
This note will further explore the developments contributing to the socialization of research and their impact on research and research institutes. It will focus more on technologies than on science per se, because applications and usage will become the main drivers.

Introduction

If our society must be characterized as a knowledge society, the production and use of knowledge and its institutions can no longer be confined to secluded islands (campuses, science parks), but will literally permeate all corners and sectors of society. In my view this is the essence of socialization of research. Whether we like it or not, and how many difficulties this may pose, scientific research and technology are becoming the "property" of everybody and increasingly will become subject of public guidance and political decision making. Socialization of research is not taking place because people do not understand or maybe even fear impacts of science and technology. No, it happens because what people think, want and do has become central to the development of science and technology. Socialization of research is simply happening because it is the development characteristic of a society in which knowledge is becoming the main driving force. And just like in agricultural or industrial societies in the past it leads to (re-)invent the institutions and mechanisms which allow the knowledge society to function properly.

This note will further explore the developments contributing to the socialization of research and their impact on research and research institutes. It will focus more on technologies than on science per se, because (as will be argued) applications and usage will become the main drivers.

What do we want science and technology to do?

"Now remember, I'm ready to do anything or be anything you want or need" said Spiritual Machine Molly to author Ray Kurzweil in The Age of Spiritual Machines (1999). This quotation summarises in one sentence the potential benefits and problems of the future development of technologies and their consequences. Its implications go way beyond Kurzweil's analysis of machines outpacing humans. It leads directly to a very basic question: what do we want these very flexible and versatile enabling technologies to do?

The question is not new, certainly not if we start thinking about applications of technologies. Already more than 20 years ago business concepts like mass-customisation pointed towards delivering individualised products and services. The growth of the Web, e-trade and a drive towards one-to-one marketing strongly favour and reinforce possibilities of individuals to choose and even to build their own

preferred arrangements. Technological tools like computers, mobile phones, cars, etc. increasingly can be adjusted to personal needs and preferences. Some even have learning capabilities to do this automatically. These technologies provide growing opportunities to shape the final 'usage-innovations' by the users themselves. What this means is that *the users no longer only select and adapt specific technologies for their own direct use, but in the process of using also "invent" and develop new technologies, or at least new applications.*

This may seem typical for the development and use of ICTs, but in a not so distant future it may also be the case for bio-technologies and materials or nanotechnologies and life sciences, provided that tools for easy and cheap manipulation of the basic building blocks (genes, atoms) become available to a wider public in a similar way as manipulation of information (bits) has become ubiquitous. Most new technologies have the character of highly versatile tools and there is a tendency of these tools to become very cheap. As a consequence the tools are available for everybody and with the growth of higher education more people have the skills to play around with these tools.

Personal computers and mobile phones are good examples of how this inspires ordinary users to become inventors and innovators. "Personal Genomics" is moving in the same direction, with – as a first step - genetic screening tests being on offer for €1000 or less.[1] The number of demonstrations of a "personal desktop manufacturing" machine (a.k.a. Fabber) is rapidly growing: MIT has its famous FAB Lab (Fabrication Laboratory) project, Swiss researchers have shown their model in 2007 and a more recent example comes from Bath University (the RepRap or "Replicating Rapid Prototyper"). And I only have to go to my colleagues to see similar machines. Also in the field of energy we can see an explosion of the number of promising research directions with a focus on small scale user controlled appliances and related services.

In this environment it becomes more and more important to build ideas and visions of what we want the technology tools to do. And this environment is very different from the classical market place where we voice our preferences by buying (or not) and in doing so help to coordinate supply and demand.

For many large companies - in particular in ICT-based sectors - this is a day-to-day reality. The number and range of choices they have about what to produce and how to deliver new products and/or services has grown enormously. And their clients are pushing for even more possibilities. The main problem for companies is no longer to invent, develop and market new products or services. *Their main problem is to choose or to select what to make*.

The technological basis for this is in the first place a continuation of the pervasive ICT-developments of today (increasing memory, processing, storage, networking, transmission capacities and increasing software capabilities), combined with further technological convergence e.g. based on wireless networking and next generation Internet technologies. These technologies all contribute to the dominance of distributed networking as the paradigm for future developments. There is a general trend to put more power and means of control in the hands of users. And developments can go very fast: it is only 20 years ago that PCs changed the centrally controlled 'master-slave model' of mainframe computing into a 'client-server model'.

The promise of social technologies as complementary marketplace

For some time now new systems are being developed in ICT and surprisingly enough these new systems have many resemblances with the complex interactions between many actors which are characteristic for the "invisible hand" of market coordination: WEB 2.0, social networking, peer-to-peer computing, grid-computing, etc. all somehow build on the free interaction of individuals and their ICT-appliances and suppose an exchange of "values" on equal terms, similar to a traditional market place. It is however not the atomistic anonymous marketplace which as a vision or "ideal" dominated the past 25 years. It is again the marketplace where everybody knows each other and where trust is one of the major "rules of the game". Another difference with "traditional" market coordination is probably that these new mechanisms are much more complex and do not limit themselves to the coordination of supply, demand, quality and prices of goods and services. They also allow coordination of much more complex behaviour and interaction, including group decision making, the building and rapid spread of shared visions, preferences, and "cultures".

So the new technologies not only force us more and more to think about what we want them to do, but the same technologies also provide us with the means to turn this into a social and collective process in a

way traditional free market thinking could never have foreseen. This may also provide a basis for collective processes of trial-and-error and learning by doing.

Could it be that a "market" for ideas and preferences is going to take the place of the market for goods and services? In other words, are our individual and collective ideas and preferences becoming more important as steering mechanism of society, partly helped by the increasingly rich and easily accessible technological environments? Can the top-down mechanisms of policy making and politics be complemented with highly effective bottom-up processes of defining needs, wants and preferences, which serve as guidance for the production of goods and services? Is civil society going to gain in importance as a societal coordination mechanism (next to market and politics)?

Consequences for research and technology

The socialization framework outlined above in an explorative and sometimes even somewhat speculative manner leads to a number of challenges for research and research organisations. Without making any attempt to be exhaustive I will shortly outline two groups of emerging changes which I expect to deepen over the next few years: changing relations between the key players in research and changes in de modes of research.

Changing relations between key players

The most pervasive factor of all is the development of networked innovation systems and networked R&D. Companies and research organizations can only survive by engaging in extensive networking with other players in the innovation system. The keyword is *open innovation*.

Old 'closed' innovation	**New 'open' innovation**
• We have the smartest people	• Many smart people outside
• We discover, develop and market ourselves	• Internal R&D cannot cover all needs
• To be first to market means winning	• External R&D also creates value.
• Create most and best ideas means winning	• To achieve market growth means winning (also if it has to be shared)
• Control IP to control entrance of competitors	• Profit is in combining internal and external processes in a good business model
	• Sharing IP is becoming the rule

Table 1. Open vs. closed innovation principles.

Under the rules of open innovation networking and outsourcing of R&D by companies in collaborative programs and projects is growing. In many cases this goes hand in hand with the growth of mixed public-private funding models. The characteristics of different science and technology areas (e.g. compare development of IT systems for enterprise resource planning with stem cell research) or different markets (e.g. compare chemicals where capital investment seems to be the dominant factor with pharmaceuticals where IP protection is dominating) make it increasingly difficult to think in terms of fixed roles for the players in the research and innovation systems. The actual division of labour between players may differ from case to case.

Several developments lead to a *growth of public interest* involvement. This was already taking place before the crisis and the following wave of demand driven research and innovation programs. In Europe we are talking about lead markets and grand challenges in which the public interest to foster innovation and to address major societal problems (climate, ageing society, etc.) comes together with private sector interests. At the same time traditional linkages between government research funding and actual research programming are becoming weaker. In modern democracies many public sectors like education, health care, transport, energy, communications and welfare services are gradually being liberalised. The privatised players in fields of public interest are often becoming major research agenda-setting stakeholders with rather independent strategic powers. Research organizations usually still have strong linkages with government departments, but increasingly they are building stronger linkages with the independent agencies and (public) companies that are now responsible for the execution of the former public tasks. This trend adds to the growth of research networking between public and private sector interests.

Changing modes of research

The general trends outlined above already have contributed to profound changes in the modes of research which can be described as two pervasive trends of convergence, first, the convergence of fields of research and technology and second, the convergence of stages in the cycle of knowledge development and deployment.

We have entered a period in which different science and technology areas are not only mutually dependent but in which the actual combining or blending of technologies leads to speed up innovation processes and introduction of new applications. The public discussion about the newly arising opportunities and consequences of such *technology convergence* was stimulated by the 2002 NSF conference report on NIBC convergence (nano, info, bio and cogno). In 2003 the European Commission established an expert group to study the consequences of technology convergence for Europe. In the meantime convergence thinking has become mainstream. There seems to be a growing common scientific base for the converging technologies: mathematic modelling, complex systems theory, modelling biological systems, growth of cognitive sciences, etc. But convergence does not stop at the borders of "hard" science and technology. The growing importance of usage and the growing role of users also lead to a further *convergence with socio-economic research and humanities*. Some of the backgrounds are the following:

- The size of investments in new technology development makes it increasingly risky for companies and research organizations to make such choices in isolation. Risk aversion strategies could in a knowledge driven society also turn into a drive toward openness and collaboration.
- The development of technologies for new service applications is a process involving many different actors and is often even driven by the end-users.
- Making innovations work in social and entrepreneurial environments and at home requires many complementary skills. Growing complexity has led to the growth of 'mode 2 knowledge organizations' and in particular the growth of a vast sector of 'knowledge intensive business services' as necessary parts of innovation systems.[2]
- And finally, the new generic technologies of ICT, biotechnology, nanotechnology, etc. often touch upon the fundamentals of interactions between people, their health and well-being and on the properties of things. People want to be actively engaged.

Therefore social factors and economic impacts have become part of the research process in the very early stages. Nanotechnology research programmes around the world are almost everywhere complemented by a social sciences research programme studying social, economic, cultural and ethical factors. This kind of broad multidisciplinary research approaches is rapidly growing in importance.

A particular, but clearly related change in the research process itself deserves separate attention: the converging or *"collapsing" knowledge chain*. This refers to the 'end of the linear model' which goes from fundamental science, via applied science and product development to marketing. Developments in the nature of scientific research itself (converging technologies offer good examples of a "let us see if this works' experimental model), competitive pressures on the speed to deliver and the growing need to involve users in the process of technology development compress the linear model in time and often even lead to a direct mix-up of the different stages. At the same time the dividing line between the producers of science and technology and the users becomes very thin if not obsolete. Not only can we find an increasingly large number of cases in which users have become producers, but it has led to fundamental changes in the research process as well. New research models like "living labs" and "crowd sourcing" are signs that the point of gravity in science and even more so in technology is shifting towards users and application environments.

Convergence and differentiation in research organisations

These drivers and trends will in the near future lead to further changes in the shape of scientific research and technology development. For individual companies with a sizable R&D capacity it becomes increasingly difficult to develop and exploit all the potentials of this research within the boundaries of the company. In addition companies are starting to take up public research interests. Universities more and more need to show their relevance with reference to the contribution they make to welfare and quality of life. Together with a growing pressure on the budgets of universities this leads to a growing drive to

exploit the results of their work in every possible way. They take the public goal of innovation on board and not only put the exploitation of research results higher on their agendas but are also putting their competences to use for client driven work. Large and small public research organisations, whatever their place in the traditional knowledge chain, are being challenged by these developments. All organisations are part of a converging research system with many complex linkages internally and with outside stakeholders.

To distinguish itself from other players a research organisation on the one hand needs to specialize and on the other hand needs to build the external linkages necessary to cover the whole knowledge chain and relevant complementary fields of science and technology. But all organisations will have to be very receptive and transparent for users and the wider public interest. And this is where the new social technologies will play a major role: they provide good tools for building and maintaining linkages, and for sharing strategic thinking and collective priority setting.

Socialization of research means that science and technology organisations learn how to directly involve society in their day to day work.

Notes and references

[1] Some still think that this could never happen in the field of life-sciences, but isn't that precisely what most experts were thinking about computer technologies before 1980, before the advent of the PC and computer networking. And of course, the information technologies themselves will be a great help in building and mastering the cheap tools for end-users in all other areas of technology.

[2] See Gibbons and others on 'The new production of knowledge'.

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