The Innovation Policy Network

SIX COUNTRIES PROGRAMME

What would Walter say?

50 years of innovation politics

Jos Leijten (Ed.)

Established in 1975, the 6 Countries Programme provides a platform for critical discussion and analysis of innovation policy issues and for the exchange of experiences and best practices in the field. Its primary objectives are to contribute to a broader and deeper understanding of innovation processes and their impact on economies and societies., to anticipate future policy needs, and to foster greater cooperation among policy researchers and decision makers from both government and business sectors.

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Contributions from the 6CP workshop The Hague,
16 December 2016 and other materials.

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Most of this book is the result of a 6CP workshop with the same title which was held in The Hague on 16 December 2016. The first and the last contribution in this book were presented at an earlier workshop which was held in Vienna in 2015, on the occasion of the celebration of the 40st anniversary of 6CP. The first (Leijten/Loikkanen) scans through the development of 40 years of innovation policy topics and debate. It signals a number of unresolved issues and related research needs. It ends with an outlook to the issues which will dominate the near future of innovation policy thinking. The last contribution, by Lennart Elg, focuses on learning as the core of innovation and how policy learning must be in the core of policy efforts. The paper by Patries Boekholt on mission oriented innovation policies is also an update of a version presented in 2015. It is included here because mission orientation goes back to the early days of innovation policy thinking.

We hope that this book helps to understand how important it is to remain critical in our analyses and discussions, but also how constructive solutions must be brought to politics. And we hope that it helps to keep some of the history of innovation policy thinking alive.

Jos Leijten

On behalf of all who contributed to this book, the present colleagues in 6CP (Wolfgang, Torsti, Ken, Anne-Lieke) and everybody who was there before us.

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Preface

The title of this book is "What would Walter say?". It is written to honour the visionary contributions of Walter Zegveld to the early days development of innovation policy and innovation thinking. But it should be stressed that Walter was not alone. The 1970's were the founding years for the fields of innovation research and innovation policy research. The development of the academic profession was complemented by a push to develop policies for stimulating innovation in industry. Walter Zegveld was one of the people who used his political connections to put innovation on the political agenda. But there were more of his kind. The name of Walter in the title of this book should thus also read as a placeholder for at least a dozen other names. The people with these names were doing similar things, with the same visionary drive, in different countries in Europe, Canada and the USA. The abundant references to the role of networking and mutual learning in this book confirm the growth of this practice oriented community. 6CP was an important vehicle (see more on 6CP in the appendix to this book). But what is more important: the pioneers were successful. Innovation policy became part of the political agenda in most countries around the world.

That is what this book is about. With a focus on the role of Walter Zegveld in the Netherlands, it shows how the field of innovation policy thinking has developed. Some of the contributions stay close to what Walter Zegveld has done and how his combination of critical and practical thinking and acting helped to gain the necessary political influence. These should be read as exemplary for the work of Walter's brothers-in-arms in other countries. Other contributions in this book analyse how certain ideas and concepts in innovation policy have developed over the past 50 years. All authors wrote their contribution with the title question "What would Walter say?" in the back of their minds.



Walter Zegveld (1930-2016)

Founding father and source of inspiration in innovation policy and innovation science

Frits Prakke, Jos Leijten

Few people have been as influential in the rise of innovation policy in the Netherlands and Europe as Walter Zegveld (1930-2016). His engineering background and international policy experience in the 1960s enabled him to see that technological innovation is a key factor in the competitiveness of firms and of countries, and that technological innovation is not just the result of a clever inventor and/or of good basic research, but also requires a favourable political environment and other conditions such as good collaboration between key-players, even when they are competitors. He combined these insights with a practical orientation towards the future and an outstanding feeling for the politics of technological innovation and the interests of important stakeholders. Walter had an extraordinary 'feel' for the needs of the future and created the conditions for both himself and others to do research and develop policies and strategies on such topics. Some of his most important insights and preoccupations concerned the need for innovation in small firms and start-ups; the importance of multidisciplinary collaboration; the need for deregulation in the telecoms sector; and the critical importance of developing strategies for the environment and undertaking research on the economic and social opportunities and consequences of automation and computerisation.

Walter Zegveld was an inspired pioneer of future-oriented, strategic and practical innovation, first in The Netherlands Organisation for Applied Scientific Research (TNO) and later in the broader contexts of the Netherlands and Europe as a whole. In 1953, after having been trained as an engineer in Shell Research, he joined the Ministry of Economic Affairs and became a diplomat at the Dutch Embassy in Washington, acting as a science attaché. In this role, he developed his exceptional networking skills and his talents were noticed by the North American Rockwell Corporation, which offered him a commercial position in Aerospace. Over subsequent years, however, he developed an aversion to the sale of jet-fighters. The story goes that he had to entertain 12 US generals at an air show in Geneva. As the Rockwell representative, he had to pick up the generals at the airport, where each of them arrived in his own plane. This obscene waste by the industrial-military complex was too much for the grandson of a Polish miner from the German Ruhrgebiet. He quit.

At the end of the 1960s, TNO wanted to become a major player in research for the nuclear industry. Next to the brand new TNO buildings in Apeldoorn, an experimental nuclear reactor was planned. The engineers of TNO thought that success would depend primarily on good marketing and, to do the job, they appointed Walter Zegveld, hoping that he could exploit his excellent international network in the industry. A team of 'the best and brightest' people in TNO was set up to realise the nuclear dream. But soon it turned out that nuclear technology was a maze of uncertainties and contradictory interests. Which refining and processing techniques should be used? Which technologies should be developed: fission or fusion? How should cooling and nuclear waste be tackled? And how should the critical issue of public acceptance be approached, especially since TNO engineers, for instance, had calculated that, if all planned nuclear plants in Germany were to be realised, the Rhine would be boiling when it entered the Netherlands and that the price of crude oil would determine the economic feasibility of nuclear power.

Thus, TNO's focus on nuclear research soon became a focus on future research. Zegveld was one of the very few Dutchmen who had contacts with French, Italian, British and American institutes for futurology and systems theory. He sent a TNO researcher for six months to work closely with futurologist Herman Kahn at the Hudson Institute. He visited Jay Forrester and the MIT Center for Policy Alternatives, where research was being undertaken on the 'Limits to Growth' for the Club of Rome. And several TNO-researchers were involved in collaborating with the International Institute for Systems Analysis in Vienna.

The major conclusions of international studies on the viability of nuclear power were enthusiastically transmitted in the Netherlands by Walter Zegveld. The first was that nuclear energy was not the energy of the immediate future, if only because the price of crude oil was expected to remain low for at least thirty years. The second conclusion was that the possible negative consequences of technological trends for people and the environment should be thoroughly investigated and eventually regulated, implying the need for systematic 'Technology Assessment'. A third conclusion was that small scale technological innovation, entrepreneurship and new start-up companies should be nurtured, implying a switch in emphasis of conventional government support policies for industry, away from 'big firms' to 'SMEs'. Another general lesson for engineers was that future technological innovation had to be less 'technology push' and more 'demand pull'.

For several years Walter became the indefatigable messenger of these new elements of innovation policy in several ministries, such as the Ministry of Education and Sciences and the Ministry of Economic Affairs, as well as in the Prime Minister's office and the main advisory council of the government, the Netherlands Scientific Council for Government Policy (WRR).

At first there was strong resistance. The vested science faculties feared budget-cuts in their most prestigious projects. Big multinationals had in-

vested in developing and building nuclear reactors and feared for their R&D subsidies. The TNO-management was likewise resisting change, seeing its nuclear project – the much-wanted chicken with the golden eggs – threatened. Slowly but surely, however, cracks started to emerge in the established 'Big Industry, Big Science and Big Government' consensus.

Walter Zegveld also played a key role in the establishment (in October 1976) of a strategy research group in TNO, which in 1980 became a new research institute under his management, the Centre for Technology and Policy Studies (TNO-STB). At last the Netherlands had its counterpart to, for example, the Fraunhofer Institute for Systems Analysis and Innovation in Germany and comparable research centres in the UK (e.g. SPRU at the University of Sussex and PREST at the University of Manchester). This enhanced its ability to make important contributions to international initiatives such as the EC FAST programme (Forecasting and Assessment in the field of Science and Technology), which started in 1978, and to the 6 Countries Programme (6CP), which was established in 1975 by a small network of individuals in six countries, one of whom was Walter Zegveld.

The 6CP set out to create opportunities for mutual learning between international peers in policymaking, research and industry in an open and trusted environment. It was intended as an alternative or complement to OECD activities in the field, which were dominated by traditional macro-economic views. Reflecting the lessons of nuclear research mentioned earlier, and to some extent the preoccupations of Walter Zegveld, the debate about innovation policy in the mid- to late-1970s focused on questions such as how to create new business opportunities through large scale mission driven technological projects ('grand projets'); how to best support SMEs as important drivers of innovation, jobs and economic growth; and how to develop the 'technological culture' that ensures that new developments are well-embedded in society.

But it was not just these more strategic policy questions that interested Walter. The day-to-day innovation practices of young companies and SMEs were the focus of 'Project Industrial Innovation'. In this project, a large number of innovation consultants were trained by TNO and hundreds of companies were aided in their innovation efforts. It started in 1976 as a collaboration between TNO and the Ministry of Economic Affairs and lasted until 1984. Offshoots remain active in the Dutch innovation system to this day.

In 1979 (with the fall of the Shah of Persia), the world faced a second oil crisis. This raised awareness about the oil dependency of important sectors of the economy. In the same year, the Dutch government published its 'Innovatienota', in which an effort was made to resolve some of the tensions that existed between conventional and new perspectives on innovation policy and practices. Walter Zegveld was the prompter behind the scenes, convincing progressive policymakers in important ministries that the Netherlands would fall behind in industrial competitiveness and employment without a strong collaborative focus on innovation.

The arguments advanced by Walter and others eventually convinced the traditional powers of Big Industry and Big Science. Walter Zegveld's contributions were based on research undertaken by the TNO Centre for Technology and Policy Studies (TNO-STB) and other international research findings that had been discussed in the 6CP. The same sources were important for the manifesto 'Morgen Brengen' ('On Industry and Employment in the 1980s'), which he wrote together with the D66 (liberal democratic party) leader, Jan Terlouw.

In 1981, during a period of deep economic crisis, Jan Terlouw became Minister of Economic Affairs. In 1982, the so-called 'Wassenaar Agreement' ('Akkoord van Wassenaar') was concluded between the government and all

social partners. It is generally seen as the start of the 'poldermodel', the culture of negotiated compromises, which arguably enabled the Netherlands to emerge from this crisis better than many neighbouring countries. In the same period, TNO-STB contributed with a report that identified the most promising fields of innovation for the Netherlands. This was the first of a long series of TNO technology forecasting studies.

By far the most important innovation policy instruments developed in those days were the so-called 'Innovative Research Programmes' (IOPs). Because there were about 10 such targeted programmes, the resulting profile for overall research funding did not deviate significantly from that produced by the dominant system of generic research funding. But their existence recognised the need for industrial innovation and did create the necessary, early conditions for research-industry collaboration. Only 10 years later, in 1989, the so-called 'Innovation Centres' aiming specifically at SME support were established.

In addition to being an innovation policy diplomat and pioneer, Walter Zegveld was also an entrepreneurial and inspiring research leader. His presence at TNO-STB raised interest in the field and attracted funding and talented researchers from academic and government departments, many in search of a more challenging workplace and the freedom to explore exciting new topics, often in collaboration with partners drawn from Walter's extensive international network.

Under the banner of systems analysis, a multidisciplinary group of researchers (including scientists, engineers, economists, management scientists, political scientists, social scientists, mathematicians, historians and philosophers) worked together on strictly-budgeted, client-driven projects. Each August, Walter would announce that the financial outlook was such that the group could expect to be bankrupt within 9 months. But at the end of each financial year there was always a tidy financial plus. By the time he left TNO in 1990, TNO-STB employed about 60 researchers, of which 25 held a PhD and more than 10 had (part-time) professorships.

But Walter's domain extended beyond TNO-STB. Between 1981 and 1990 he also headed the new TNO division for Policy Studies. As well as TNO-STB, this included several other TNO centres and groups, of which the Centre for Infrastructure, Transport and Regional Development (TNO-INRO) was the largest.

After he left TNO, Walter held a professorship in Amsterdam at the Free University. He was also a board member of several companies in the field of ICT (e.g. KPN) and chaired several advisory committees for the Dutch government. Most prominent amongst these was the 'Committee of Wise Men', set up to evaluate proposals and assess the progress of so-called strategic knowledge infrastructure investment projects, funded out of the immense proceeds of Dutch natural gas. This gave him a chance to fight against the fragmentation of research and research funding, which was a topic he and his son Marc addressed frequently in the almost 100 columns they wrote together for the Financiële Dagblad.

Walter's voluminous publications stand as a permanent testament to his endeavours in the field of innovation and innovation policy. In particular, the timing and titles of the books he wrote, many of them in conjunction with Roy Rothwell from SPRU at the University of Sussex, illustrate the timeliness and pertinence of his seminal contributions to key debates in the historical development of innovation practice and policy development.

- Roy Rothwell and Walter Zegveld (1978), 'Small and Medium-sized Manufacturing Firms: Their Role and Problems in Innovation-Government Policy in Europe, the USA, Canada, Japan and Israel'. Report to Six Countries Programme on Innovation, TNO, Delft, Netherlands, June.

- Roy Rothwell and Walter Zegveld (with foreword by Christopher Freeman) (1979), 'Technical Change and Employment', St. Martin Press, New York.

- Jan Terlouw en Walter Zegveld (1979), 'Morgen Brengen; Over industrie en werkgelegenheid in de jaren 80', Uitgeverij Bert Bakker, Amsterdam.

- Roy Rothwell and Walter Zegveld (1981), 'Industrial Innovation and Public Policy: Preparing for the 1980s and 1990s', Frances Pinter, London.

- Roy Rothwell, Walter Zegveld (1985), 'Re-industrialisation and Technology', M.E. Sharpe Publishing, New York.

- Walter Zegveld, Christien Enzing (1987), 'SDI and industrial technology policy: threat or opportunity?' Frances Pinter, London.

Forty Years of Innovation Policy Research - Lessons and Outlook[1]

Jos Leijten and Torsti Loikkanen

Introduction

The policy field that we now know as innovation policy has its roots in what, 50 years ago, was known as technology policy. Other concepts and policy approaches that are also seen as closely linked include industrial policy, economic growth policy, systemic innovation policy, environmental policy, transition policy, intellectual property policy, trade policy, and market regulation and stimulation. All of these have had, and continue to have, an important influence on the development of innovation policy and the focus of related research activities.

This chapter does not try to cover all aspects of the development of innovation policy and innovation policy research. A wide range of textbooks attempt to do this and, specifically with regard to scientific research on the evolution of innovation practice and policy, there is an excellent overview by Ben Martin (2012). We do, however, present an overview table of concepts and key publications to support the personal perspective developed in this contribution, which is based on our own experiences and our own evaluation of the state of the art. In it we try to identify a number of issues

1 The first version of this paper was written as a background document for the 40-year anniversary conference of the 6 Countries Programme. Inevitably it has become something of a personal account.

that we think should be on the agenda for future research and policy debate and we try to outline a (rather optimistic) view of future directions.

Innovation is a widely-used catchword today, but in fact the concept of innovation itself is not so new. It was already used before 1900, albeit sparsely (Godin 2008). Joseph Schumpeter laid the ground for a widely accepted economic theory of industrial innovation roughly between 1920 and 1940. And very rapidly his thinking translated into a de facto form of innovation policy with the establishment of public technological research centres, grouped nowadays under the acronym of RTOs (Research and Technology Organisations). Many RTOs around the world were established just before or shortly after the Second World War, with the explicit mission of providing research and development, technology and innovation services to firms and other clients, designed to support their competitiveness and sustainability and thus contribute to economic growth. Sometimes these RTOs were established at the same time and as part of the same policy package as other more fundamental university research (funding) initiatives (e.g. the establishment of TNO and NWO in the Netherlands in 1930 and the Fraunhofer Gesellschaft and the Max Planck Society in Germany almost 20 years later). The history of VTT began on 16 January 1942, when the president signed the Act on the Technical Research Centre of Finland. Its mission was "to engage in technical research for the benefit of science and society". It shows how important the role of research and technology transfer was seen in the early days of thinking about what we now generally call innovation policy.

For most of their careers, the authors of this chapter worked for TNO and VTT respectively, where they witnessed a growing interest in the economic and societal implications of technology development. In the mid-70s, TNO had its strategy research group, which became an Institute in 1981 (the Centre for Technology and Policy Studies – TNO-STB). Prior to this, Chris Freeman had started the Science and Technology Policy Research Unit (SPRU) at the University of Sussex in 1966, with a research programme that

built on the works of Schumpeter. Other universities followed suit in later years. Fraunhofer ISI, the Institute for Systems Analysis and Innovation Research in Germany, was established in 1972. At the Technical Research Centre of Finland (VTT), the VTT Group for Technology Studies was established as a fixed-term project in 1992, with permanent status granted in 1995. But even though the concept of innovation was well-known and used (TNO had an Innovation Advisory Project that targeted company practices from 1976 until 1984), innovation was still seen as something that largely belonged to the private domain of industry and business. In public policy spheres, the keywords at the time were science policy, technology policy and, let us not forget, industrial policy.

The applied research agendas of most science and technology policy study groups had many similarities. Their research services consisted of research about the dynamics of technological change and innovation; industrial renewal; assessment of the socio-economic and ecological impacts of technological change; assessment of the impact of science, technology and innovation (STI) policies (with the related development of STI indicators); performance evaluation; and foresight studies focused on technological and socio-economic change. The reasons and rationales for government support and intervention in STI are a recurring theme in all these research areas. The theory underpinning most of them is largely based on systems analysis and evolutionary (or neo-Schumpeterian) economic thinking. But the importance of many other economic schools of thought, such as the 'new growth theory', was also recognised. Interdisciplinary research approaches and research teams were a common way of tackling these topics.

Vannevar Bush put science policy on the map in the US with his 1945 report entitled 'Science, the Endless Frontier'. After the Second World War, the US needed jobs for returning soldiers. Vannevar Bush – as a sort of New Economy advocate avant la lettre – advanced the premise that what we learn and discover through science is an endless source of new economic activities and wealth. For a few decades, 'science policy' became the dom-

inant mode of thinking in our field: invest in science to invent, which will then allow industry to innovate and new markets to grow. It was the period of 'Big Science', which was inspired by the way in which the atomic bomb was developed during the war and the continuation of this model in the development of nuclear power and space exploration after the war.

Over time, however, discussions about 'science policy' were complemented by discussions about 'technology policy'. When Chris Freeman established SPRU at the University of Sussex in 1966, it was commonly referred to as the 'Science Policy Research Unit', but its full title was actually the 'Science and Technology Policy Research Unit', reflecting the shift in emphasis of contemporaneous debates about the importance of both science and technology policy. There were several reasons for this growing interest in 'technology policy'. These included: a) speculation about fields that were likely to lead to the development of new 'big technologies' (like the nuclear and space domains); b) concern about signs of decline in traditional industries and consequent interest in new, growing fields of technology; and c) growing resistance during the 1970s to the environmental and human risks posed by large new technology projects, which led, for example, to the establishment of Office of Technology Assessment (OTA) in the United States in 1972. Gradually, technological change and its societal impact had become a legitimate focus of concern for public policy making.

The concept of innovation and innovation policy: towards growing complexity

The widely-accepted methodology for collecting statistics on R&D and Innovation is set forth in the Frascati Manual, prepared and published by the OECD, and the Oslo Manual, published jointly by the OECD and Eurostat. The first Frascati Manual (officially known as The Proposed Standard Practice for Surveys of Research and Experimental Development) dates from as far back as 1963. The updates of these manuals reflect how the scope of the innovation concept has broadened continuously over the years.

Gradually it has come to incorporate service, social, organisational, behavioural and other forms of intangible innovation, and the concept of 'invention' as a single act has been extended to cover aspects of learning and discovery within a more systemic concept of innovation (Lundvall [Ed.] 1992; Elg 2014; Foray *et al*, 2009). The concepts of learning and discovery have also broadened to include entrepreneurial discovery as well as scientific discovery; community based learning as well as scholarly learning; and policy learning as well as scientific learning. These and many other conceptual changes reflect what are probably the most striking changes in the field over the past 40 years: the spread of 'innovation-thinking' and the growth in the number of institutions and people in all sectors of government and society with the term 'innovation' in their task description. Innovation thinking has become ubiquitous.

One downside of this is the potential for tautology, where the terms 'innovation', 'invention', 'learning' and 'discovery' are used in a confused, conceptually muddy fashion, but at the same time we must acknowledge that the spread of innovation thinking is a sign of a profound change from an industrial economy and society to a knowledge-driven economy and society. And when we go deeper into the fields of innovation research and innovation policy, we find that, over the years, many topics related to this change from industrial society to knowledge society have been addressed. In this chapter, we will briefly discuss why some of these topics became important in research and policy agendas. Following a small series of 'case studies', we then attempt to derive a clearer picture of the future of the field.

Public-private relationships

Thinking about *public-private relationships,* in particular the issue of how much public intervention in innovation is beneficial, allowed and/or needed, has gone through considerable 'swings' over the past 40 years. The two extreme positions – only intervening via the use of generic measures

on the one hand and strong intervention involving government priority setting and targeted funding on the other – is probably one of the most discussed dichotomies in innovation policy research. 6CP addressed the issue implicitly and explicitly in several conferences or workshops (most recently in 2009, see Elg and Leijten 2010). At the very least we can see broad shifts, first from large-scale public intervention ('grand projects') to very generic hands-off approaches underpinned by 'market failure' arguments (neoliberalism), and more recently a return to stronger interventionist thinking (Mazzucato 2013, Block 2011, Atkinson 2012, etc.), in which the role of longer-term government support for new technologies is again being stressed. The changes in thinking have also affected government policy itself, very often revealing internal contradictions within governments (as exemplified by 'classical' tensions between ministries of economic affairs and science ministries, or innovation-oriented ministries and finance ministries). In recent years, some of these changes have translated into growing foci on demand-driven approaches; on the need for public-private collaboration; and on attempts to tackle 'grand challenges'. These new foci are undoubtedly of great importance, but the actual prioritisation and shaping of such policies has proved extremely challenging. Consider, for example, the problems experienced by the European Human Brain Project, which adopted an approach akin to a traditional 'Grand Projet' in order to tackle a current 'grand challenge'. Launched in 2013, the original intention was that it would run for 10 years and involve more than 100 research institutes and 7000 person-years of effort. The project had a clear technological focus on mapping, measuring and simulating the human brain and aimed at the development of a full-scale model. Soon after its launch, however, the project goals were contested by a sizeable group of cognitive neuroscientists, some of whom felt that their specialist approaches had no place in the project. Answering to these pressures the Human Brain project has gradually lost its distinct focus.[2]

2 See a discussion of this issue in the Nature editorial of 25 March 2015 (Vol. 519, Issue 7544).

Sustainability

During most of the history of 6CP, '*sustainability'* has been an issue. Starting from an environmental policy perspective, which prioritised the evolution of cleaner, healthier living environments, policy discussions and initiatives gradually encompassed broader goals via the incorporation of concepts such as 'sustainable economies' and 'sustainable/resilient cities'. A more recent focus has been on even greater complexities. Concepts such as 'systemic innovations' or 'transitions', based on the recognition that some changes necessitate 'transformative innovation', involve the radical transformation of the techno-economic base (e.g. from a dependence on coal, oil and gas energy sources to a primary dependence on renewable energy sources such as solar, wind and hydrogen).

But the relationship between environmental policy and innovation policy has historically been weak (see 6CP conference 2002 and workshop 2011) and remains so to this day. Our best explanation is that sustainability is often approached from a *goal-driven planning* perspective (Giddens 2009). Innovation, however, has a distinct focus on creating *new technological and organisational opportunities*, often involving competing trajectories. Over the years, the dominant discourse has maintained that combatting climate change requires urgent 'transitions' that necessitate strong government intervention. An alternative would be the development of a challenge and demand-driven approach to sustainability-oriented innovation, but progress in this direction has been slow and has not yet been very successful, mainly because politicians prefer the relative certainty and short-term effects of environmental planning measures over and above an innovation-oriented approach with an open-ended focus on longer term opportunities (Montalvo and Leijten, 2015). Moreover, solutions to long-term complex challenges require multidimensional 'horizontal' interactions between various policies that have proved difficult to realise in practice. Experience has demonstrated, for example, how subsidies designed to stimulate demand have sometimes led to the disruption of

once-thriving innovation systems and clusters (wind, solar), and how transition-oriented policies can under- or over-estimate the speed of diverse technological developments (e.g. renewable energy and energy storage). This shows again that we need a much better understanding of complex challenge- and demand-driven approaches from both theoretical and practical perspectives.

Other unresolved issues

In addition to '*public-private partnerships*' and '*sustainability*', many other issues in innovation policy and research remain unresolved. Discussions continue, for example, on tax schemes to reduce the costs and/or risks that companies face when investing in research and innovation. Advocates argue that they actually do reduce risk, while opponents argue that tax measures provide no real incentive for longer-term investment, certainly not in innovation. It is 'easy money' that allows companies to do things that they would have done anyway.

Similar persistent opposing views characterise discussions about Intellectual Property Rights (IPR). Those in favour of strong IPR protection focus on the potential rewards for companies that invest in new technologies, products or services, while those against argue that strong IPR regimes stifle innovation.

Currently, even some of the old 'truths' concerning innovation policy are coming under renewed scrutiny, such as the beneficial effects of generic SME-support. Many analysts now argue that the focus should shift away from generic SME-support and towards targeted support for entrepreneurship, start-ups and fast growth companies.

Another old 'truth' that is being questioned is the concept of the 'national system of innovation'. Nowadays, at the very least, it shares the scene with concepts describing regional, sectoral and global systems. New and/

or competing concepts focusing on clusters, networks and platforms offer a more distinct geographical perspective. The concept of 'innovation ecosystem' is the latest addition. A frequent conclusion is that all these concepts are relevant, but if this is the case then one has to question how their role in innovation systems translates in a specific role they can play in innovation policy.

For us, all these issues and arguments constitute support for revisiting the original focus of innovation and innovation policy: attempts to increase the range of technological opportunities and the ways in which these are manifested in new products, processes and services. Defined in this way, technological innovation can be clearly distinguished from 'social innovation', which may act as a driver for change either in its own right or in combination with technological innovation. Starting from this (narrower) perspective on the role of innovation policy, its relationship to other types of policy, such as growth policy, employment policy, social policy, etc., can be defined. In the following paragraphs, we explore briefly some of the consequences of this approach.

The need for a new focus on technological change?

The nature and dynamics of technological change have been a regular topic on the 6CP agenda. Technological systems such as nanotechnology and ICT have become increasingly complex and are frequently characterised by interdisciplinary, generic and pervasive aspects that enable shifts from scale to scope economies. Enterprises can no longer mobilise internally all the resources and competences needed for innovation, which today increasingly depends on external sources, networks and collaboration. With the bulk of new knowledge originating from external sources, the traditional corporate lab model has almost vanished. Innovation is becoming 'systemic', i.e. dependent on the interplay of many different players and force. It is increasingly difficult to see where an innovation

originates. Innovations are combining technology with intangible service and business innovations and are increasingly emerging as a consequence of less science-driven trial and error processes and joint experimentation (e.g. living labs, shared facilities for testing and piloting). Fights about IPR are growing due to blurring and converging borderlines between science, innovation, valorisation and acquisition. But at the same time intellectual property is made accessible to collaborators and ultimately shared with them. A stronger role for 'big data' will aggravate this trend. What, for example, will the future look like when Google and/or IBM massively enter the healthcare field on the basis of their access to data and analytical capabilities? Or, in a completely different technological trajectory, what will the future look like when the field of healthcare becomes dominated by large numbers of rather unrelated and fragmented apps? These factors, which will have a profound impact on innovation institutions and techno-economic systems, will play an important role in competitive battles and power struggles between companies and institutions. Similar points can be made about 'Blockchain', primarily known as the technology behind Bitcoin, which for some observers promises to place the control of many financial and data transactions in the hands of end-users. But it is no secret that many vested players in existing finance and software platforms will try to take control of such systems.

Despite the growing political and social urgency of such questions, somehow the nature of technological change seems to have become a neglected issue in innovation (policy) research. Partly this is the result of a neo-liberalist focus on generic support measures, which almost equates innovation policy with growth policy. And partly it is a consequence of the fact that academia still has major problems with interdisciplinary thinking and research, which has led academic innovation (policy) research to become a specialist niche within management studies, or economics, or sociology, etc. There is a clear need for a new focus on understanding the nature of technological change and its implications. The systemic environments in which different technologies thrive are themselves very

different. Against this background, there is a need to reassess the value of policies and strategies concerning public-private collaboration in research, entrepreneurship, venture and other forms of risk-bearing capital, IPR, tax-measures, etc.

The key challenges with regard the dynamics of technological change in the future concern:

- How innovation strategies and the behaviour of firms will change in view of the changing nature of the technological endeavour (e.g. involving the crowd sourcing of knowledge; open innovation and new modes of collaboration; evolving governance structures for global value chains etc.);

- How new technologies will affect income, position, and behaviour of people (in their roles as community members, workers, consumers, etc.);

- How universities and research organisations will change their strategies, moving from disciplinary-oriented science and technology developers to wider drivers of technological innovation (involving shifts to Mode II and Mode III, internationalisation, etc.);

- How public policy and funding will move 'closer to the market'; closer to the identification of challenges and demand; closer to the targeting of priority areas and technologies; and nearer to the widespread implementation of cross-border policy strategies.

All in all, there seems to be a growing need for 'old-fashioned' technology and innovation analysis and technology assessment with a focus on how technology interacts with society. Not that it is currently absent from the scene, because in fields such as environmental technology, ICT and nanomedicine, for example, much research work of this nature is undertaken,

often under the new, distinctly European label of responsible research and innovation (RRI). But we have the impression that the focus of this work is primarily to feed the political debate about positive or negative societal effects (e.g. concerning the use of GMOs or nanoparticles), with less of a distinct focus on understanding the dynamics of technology and innovation in interaction with its economic and societal contexts. The current debate about robots and labour clearly illustrates this, for there is little research on how the rapid growth of the use of robots and artificial intelligence might lead to a new configuration of the labour market. And there is even less research about how policy can and/or needs to guide the transformation process.

But there are exceptions in which we find examples of 'old fashioned' technology and innovation studies that attempt to understand the industrial and socio-economic impacts of STI policies. The political legitimation of innovation policy measures necessitates the identification and assessment of the impacts of STI policies on, for example, industry, the economy and society. An interesting approach can be found in recent studies of the impacts of policies at the level of individual innovations (Hyytinen *et al*. 2012; Loikkanen *et al*. 2013). Such impact studies, however, require the existence of systematically collected and analysed data over the lifespan of individual innovations. Examples include the SFINNO[3] study in Finland and SWENNO[4] in Sweden. But studies of this kind are still exceptional.

Such studies may also feed the current debate between 'technology optimists' such as Carlota Perez (2016) or (from a very different starting point) Vint Cerf, and the 'technology pessimists', who now argue that we have entered a period in which technology (robots, artificial intelligence etc.) will destroy many jobs and lead to large scale unemployment and social disruption. Dichotomies like this do not help the development of effective

3 See www.vtt.fi/sites/sfinno/en.

4 See https://www.ekh.lu.se/en/research/economic-history-data/swinno.

innovation policies. Instead, policies need to be able to build on a deeper understanding of the dynamics of technology and innovation and related societal changes. This understanding is needed not only to improve the effectiveness of the current tools available to innovation policy, but also to develop policies that aim to manage the 'creative destruction' that accompanies the transitions brought about by new technologies (e.g. to prepare people for a rapidly changing labour market).

Globalisation, regionalisation and unequal development potential

Globalisation and the related dynamics of knowledge and innovation have become key drivers of industries and 'knowledge economies'[5]. The concept of globalisation refers to several trends spanning global markets, global sourcing, global competition, global science, and global innovation networks and platforms. Globalisation is mainly driven by the search for competitive advantage by companies and builds largely on applications of ICT. These both require and incentivise the use of global standards and the implementation of global innovation platforms. So, to a large extent, technology provides the conditions for globalisation, usually in interaction with other developments such as standardised container transport for industrial products. Multinational enterprises play a major role in R&D globalisation. Trade agreements are also a major complementary driver at the institutional level. Global IPRs are challenged by the democratising effects of trends leading to the opening of science and innovation worldwide ('Open Science' and 'Open Innovation'). Globalisation has had and continues to have a deep impact on the role and behaviour of innovation institutions.

Globalisation puts innovation policy squarely in the middle of international competition policies. It is a continuously and dynamically changing

5 See, for example, the contribution of Squicciarini and Loikkanen (Eds.) 2008, to a conference that was co-organised with the 6CP.

phenomenon and conclusions and policy suggestions drawn at any one point in time are not necessarily valid subsequently (e.g. what happened to the focus on BRICS? Has it been superseded by a focus on MICS?). The position that a company, research organisation, country, region or city wants to occupy in a global innovation system has become a necessary component of its strategic planning and subsequent behaviour. And even when one decides on a local strategy, global dynamics might interfere at any moment. A particular challenge is the development of global research and innovation funding mechanisms, because traditional national public funding procedures often seem unable to cope with the dynamics of globalisation and, as a consequence, with societal challenges that have a global reach (see Montalvo and Leijten 2015).

The globalisation of STI has been dealt with extensively in several 6CP events, including the exploration of options for innovation policy. These events have demonstrated that innovation policy research has evolved a good understanding of the phenomenon. New issues, such as the relationship between innovation policies and trade policies, have been recognised in a timely fashion. But other potentially key issues relating to inequalities that are closely linked to globalisation probably do not receive sufficient attention.[6] Three types of inequalities have been and still are important for the development of innovation systems:

Agglomeration effects and unequal development

Agglomeration phenomena epitomised by phrases such as 'success breeds success' are giving rise to 'peaks and valleys' around the world (Florida 2005). A further look at innovation indicators demonstrates considerable differences between countries in Europe, between states in the US, and even between regions in one country or state. Most evidence

6 The first version of this paper was written in 2014, before the shock of populism, nationalism and anti-globalist feelings really hit mainstream politics.

today points towards increasingly strong agglomerations. The global competition for human talent between the strongest agglomerations also seems to be growing. Scientific knowledge, a (global) public good, is necessary for socio-economic development, which leads to a debate on how less-developed countries and regions can fit into the (global) innovation economy, and how their positions can be improved through specific STI policies. Given the strength of agglomeration effects, there seems to be no easy path towards the more equal distribution of innovation opportunities and wealth. In the developing world several countries, especially large emerging economies have managed to alleviate poverty and improve welfare by investing in education, science, and innovation capabilities and institutions. In many developing economies, however, the significance of STI and related policies are not well recognised and many lack resources and expertise to set up STI. For example, brain drain of educated experts is among most acute problems in of these many countries. Among the contributing actors and factors are international collaboration, networks of policy-makers, private sector, NGOs and research communities. Moreover, development assistance policies, private charitable and philanthropy donors, and diaspora remittance funding, as allocated also to education and STI, may play important roles. Science diplomacy, international cooperation in research and innovation as an instrument of soft power and a mechanism for improving relations with key countries and regions, are essential factors in paving the way of poverty and towards a development path of higher welfare in developing economies.

A 6CP workshop in 2014 pointed in these directions, but the dynamics of innovation in relation to (global) economic geography is likely remain important topic for research and policy debate in the near future.[7] One amongst many interesting questions is whether region-states or mega-

7 Van der Giessen e.o (Eds.) (2015) Can policy follow the dynamics of global innovation platforms? Papers from a 6CP conference 14-15 April 2014, Stedelijk Museum 's-Hertogenbosch, the Netherlands.

regions will gradually replace nation-states, and whether this would make global competition among innovation systems all the fiercer in the future (Ohmae, 2005).

Inclusion/exclusion

Another important inequality topic – more closely related to the advance of a technological culture - has been how (groups of) people are included/excluded in the global economy and related technological change (e.g. digital divide, job-loss because of automation, disappearance of the middle class, etc.). On the one hand people in the more advanced economies seem to have adapted to a faster changing world of jobs, work-location and skills requirements. On the other hand, a widening income/wealth gap together with increasingly faster disappearance of middle income jobs cannot be seen disconnected from the shape of innovation and technological progress. It may very well lead to feelings of "being left out" and growing resistance to new technologies. The question what innovation actors can or should do in view of such inequalities deserves a higher place on the research and policy agenda.

Small and large companies

The more specific issue of inequalities between small and large companies has so far resulted in an almost dogmatic approach in favour of SME-support in innovation policy and regularly also in research. The supposed differences in abilities to innovate between small and large companies and their expected impacts gave rise to a broadly supported and extensive system of special support actions for SMEs. In the more recent years this line of thinking has been extended to putting very high innovation value on entrepreneurship, start-up firms and risk-capital. At the other end, some large companies seem to focus now on investing their revenues in increasing their market share by a mergers-acquisitions strategy and only a limited group of (mainly) leading ICT-companies (Apple, Google, etc.) seems

to invest in a longer-term innovation strategy. Recently ITIF has started an interesting discussion about the justification of special support actions for SMEs (Atkinson 2014). It shows there are good reasons for putting this issue in the centre of a debate. The perspective should on the one hand be analytical (What is the influence of size on conditions to innovate? What is the impact of size on the innovation outcomes?), but on the other hand it should also be discussed how innovative the different players should be, and how they might play complementary roles through their collaboration in innovation eco-systems.

The political events of 2016 (Brexit, Trump, and otherwise diverging nations and world regions) confirm the importance of deeper analysis of such inequalities and their roots and their potential consequences.

Future outlook – exploring innovation paradigm change

What might be the future outlook of innovation activities, of innovation policy and of innovation policy research in the era of austerity and thereafter if/when the rebound comes? What are the lessons from the development of the field over the past decades for future scenarios? What is realistically and feasible, and what is potentially disruptive?

As industrial and public investments in R&D have been cut during times of recession (not everywhere in the same pace, but in the end the trend seems to be inevitable) we see a growing and potentially disruptive interest in so-called frugal technology and innovation. Some companies are exploring ways in which they can break the increasing complexity - costs spiral by moving in the direction of frugal technology solutions and the related lower cost paths. Another disruption could be the result of a re-fragmentation of the world (multi-polarity) which is a real option for both geo-political and technological reasons. At the same time as the work towards a number of international trade agreements (TTIP, TPP, etc.) covering the basic rules

for competitive behaviour and level playing fields has been growing, we also see a growing search for power positions, which may foster nationalist and protectionist strategies. These may also become a more feasible option in terms of knowledge, technology and economy, as the conditions and skills to innovate have become more evenly spread between countries around the world. The talking about a relatively closed Chinese or European Internet points in this direction.

Innovation policy and innovation policy research does not have a strong track-record when it comes to analysing, understanding and dealing with "power". This can be partly explained by the "opportunity seeking" and competitive thinking in which innovation thinking originates. It leads mainly to calls for "level playing fields" and searching catching up strategies (i.e. creating opportunities) for countries or regions that so far have not managed to be part of the "global knowledge economy" or closing the West-East gap in Europe. But this relative neglect of power structures in combination with an earlier mentioned neglect of the changing nature of new technologies has meant that innovation research, probably more than innovation policy which usually has to serve economic growth, also has neglected most of the profound changes new technologies have brought to power structures and their societal impacts.

In the following we discuss a few selected foreseeable future trends of technological change and innovation policy, generally taking an optimistic position with regard to the new technologies as well as to the potential implications for politics. Next to this broad outlook, questions are raised which are of importance for future innovation policy research.

Future trends of new social technologies

We would not be surprised if in a few years from now, when thinking about it in terms of Kondratieff-cycles and a Schumpeterian approach, the financial crisis starting in 2008 will be seen as an important phase in the devel-

opment of an ICT-dominated technology paradigm, or better, of a control and management systems ICT-dominated era.[8] Many of the developments which have contributed to the financial crisis only have been possible because of the rapid growth in the use of ICTs as technologies of control and management, for example in enterprise resource planning, international finance, computerised trading, marketing, customer relations management, logistics, etc.[9] The patterns of growth and development of companies, other types of organisations and the networks between them depended to a large extent on this group of ICT applications, which are mostly built to maximise exploitation of resources (including human resources).

But it appears as if somehow limits have been reached with these centralised ICT-based control systems and the number of people advocating other types of coordination mechanisms seems to be rapidly growing[10]. On the one hand, the control systems have given companies the means to react much faster to changes in the market, but on the other hand they seem to reduce real strategic flexibility and agility, because they only "control" a limited set of parameters. Of course, these technologies have benefited citizens and consumers, and national economies, but in general

8 Writing at the very start of the dot-com bust (2001) Freeman and Louçã tend to see developments in financial and stock markets as part of the wider institutional and social changes associated with the ICT-revolution.

9 Nearly everything that moves can be tagged with an RFID chip. So the fish in fish farms is being tagged with RFID chips to be able to follow them on their way to the consumer. Googling on the topic reveals a whole world of this kind of initiatives. This is of course the ultimate control-thinking which is suitable and possibly even necessary for interactions between fully anonymous producers, intermediaries and consumers in a mass-marketplace. We should expect that systems which build on trust and communities thinking will have very different characteristics.

10 The growing movement around transitions thinking which is clearly reflecting this trend has its origins for one part in innovation (policy) thinking and for another part in environmental activism (see Grin, Rotmans and Schot, 2010).

they better supported specific company strategies in extending the scale (and scope) of operations while at the same time reducing costs. Electronic banking is a good example because it makes it possible to deal with very large numbers of differentiated clients on the one hand and on the other hand to transfer part of the costs of the service to the clients themselves (a computer and internet connection and the time to handle the transactions). The complex systemic impacts of such developments were mostly applauded as service innovations in innovation thinking. Critical analysis of these developments in terms of power and welfare has been an exception (Castells, 1996).

Like the main techno-economic systems which characterised previous waves, ICT, conceived broadly and including mobile communication, digital media, etc., will not disappear. On the contrary, these technologies will continue to grow and spread throughout the economy and daily life, just as trains and electricity have only grown in importance. But somehow ICT, digitalisation and internet of things, manage to transform itself much faster than the earlier major techno-economic systems. It can for example be argued that the characteristics and functionality of train-systems only changed with the rather recent introduction of high-speed trains and possibly about one hundred years earlier with the introduction of metropolitan (underground) networks. Electricity will change profoundly with the imminent introduction of smart grids and related growth of complex interdependencies in the scale of networks and power generation.

For some time now new technologies and functionalities are developing in ICT and surprisingly enough these new functionalities 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 (mobile) ICT appliances. The versatility of the systems, but interestingly also their

fragmentation, is growing rapidly with the growth of the "app-economy"[11]. The new technologies in principle can facilitate an exchange of "values" on equal terms and symmetric information and have some similarities to a traditional (non-anonymous) market place. This makes the social networks and platforms different from the atomistic anonymous market which as a vision or "ideal" dominated over the past 25 years of neoliberal thinking. The new systems resemble the ancient marketplace where everybody knows each other and where trust is likely and necessarily to be one of the major "rules of the game". But compared to "traditional" market coordination these new mechanisms are much more complex and do not limit themselves to the localised coordination of supply, demand and prices of goods and services. They also allow coordination of much more complex behaviour and interaction, including the building and rapid spread of shared visions, preferences, and "cultures" or group decision making (Saunders and Mulgan, 2017).

Could it be that a non-anonymous "market" for ideas and preferences is going to be built on top 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 reductionist mechanisms of policy making and politics be complemented with bottom up processes of defining needs, wants and preferences? Can they not only serve as guidance for the production of goods and services, but also give direction to innovations and thus to shaping the future by expressing our collective views or visions on actual and future needs?

11 The global application economy is estimated to grow 27 percent annually and account for 33 percent of the combined app services in 2016 when the share of handset markets is estimated to be 67 percent (Pappas 2013).

Although ICTs have to be seen as the major driving force, developments in other areas of technology like materials and life sciences show similar trends, which may support the development of new modes of coordination and governance. Most new technologies have the character of highly versatile rather generic tools (ICT, genomics, nanotech, etc.) and there is a tendency of these tools to become very cheap[12]. As a consequence, the tools become available for everybody. Personal computers and mobile phones are good examples of how this inspires ordinary users to become inventors. "Personal Genomics" is moving in the same direction, with – as a first step – (nutri-) genetic screening tests or personal genetic tests (to establish susceptibility for certain diseases) being on offer at the Web for anything between €100 and €1000. Although the interest seems to be rapidly growing, it is still uncertain how people will actually use such tests. But such an experimental or discovery phase is normal in very early stage applications of generic technologies. The number of low-cost readily available "personal manufacturing" machines (3D-printing) is also rapidly growing. And FABLABs or Makerspaces, where everybody can experiment at low cost with the new technology, are nowadays to be found in most cities. There is a growing number of easily accessible platform initiatives which integrate design, production, and marketing (e.g. Local Motors, i.materialise). In the field of energy, we can see an explosion of the number of promising research and innovation directions with a focus on small scale user controlled appliances and related services.

Somehow this (optimistic) information age discourse is showing increasing overlaps with the transition discourse which was mentioned earlier. Both

12 Most of the discussion nowadays focuses on the usage of these tools. But they also need to be produced. In most cases this is (becoming) a highly competitive global market, with a few large players. Some of these players are focusing their strategy on their market share, others seem to explore ways of vertical integration.

discourses foresee a fairly radical change in structures and governance of the major techno-economic systems which shape our working and living environments. Precisely because of the close connection which these discourses see between the development of techno-economic systems and the ways in which these systems are governed, they deserve a lot of attention in innovation policy research. But not in their usual disconnected ways of, ont the one hand, the goal driven environmentalist transition discourse and, on the other, the new technological opportunities driven information age discourse. Both approaches may learn a lot from each other. And innovation policy will benefit from integration of the two in a single new rationale.

Developments like this lead to an environment in which we need to build ideas and visions of what we want the technology tools to do. This environment is very different from the classical mass-production dominated market place where we voice our preferences by buying (or not) and in doing so help to coordinate supply and demand. And it also seems to lead away from the tendency toward more and more specifically targeted advertising and product/service offers.

After describing this rather positive ICT-technologies driven scenario, we must however also ask “a positive scenario for whom”? The promising opportunities do not reach all citizens of the globe in equal ways, as digital divides still do exist. For example, at the end of 2012 around 450 million people worldwide still live out of reach of a mobile phone signal, high mobile-cellular penetration rates do not imply that everyone owns or is using a mobile phone, and every household access to a telephone is still not the norm, in particular not in many less development countries (ITU 2014). But also these problems are increasingly solved by ‘small technology’ solutions such as solar panels to deliver electricity in even the most remote places.

Future trends of innovation policies

As already said, there is a move towards a very comprehensive approach of innovation, including economic growth, organisational structures, quality of life, new political and policy processes (governance), etc. With this broadening scope innovation policy encompasses an increasing number of rather intangible processes. But in comparison to technological product or process innovations, these more intangible processes pose enormous challenges for research to get empirical performance evidence and indicators. The more comprehensive the approach to innovation gets (or, in other words, the broader the concept of innovation), the more stakeholders and the wider public will need to be involved in innovation processes. Some analysts like Eric von Hippel and Josephine Green see a move toward "democratisation of innovation".[13] It means that increasingly we all become innovators and must decide individually and collectively about the kinds of innovation that we need and want. And this needs to be done in structures which are capable of handling considerable complexities. The question who "owns" an innovation will become increasingly important when a move to "mass-innovation" (Leadbeater, 2008) takes place. Traditional IPR thinking is then even seen as an important barrier for "democratisation of innovation". An intellectual monopoly is not necessary for innovation and in its practical outcomes it may damage growth, prosperity and liberty (Boldrin and Levine 2010).

More than ever the needs, wants and preferences of users and consumers, and co-creation by users and producers as well as public policies will become the key drivers of innovation (e.g. Prahalad and Ramaswamy, 2004). At the micro-level individuals or communities are identifying and voicing certain needs and sometimes also develop solutions. At macro-level, the identification of collective societal and in several cases global challenges

13 We prefer to use "socialisation of innovation".

is increasingly seen as important driver for innovation and as a means to create new economic growth. Entrepreneurship policies need to be supportive for new kinds of entrepreneurs. They will increasingly come from the ranks of users (and employees) and consumers that use the cheap and easy to handle tools to satisfy their own needs and wants in the context of the broader platforms. One only has to look at the ways in which the (mobile) Internet manages to inspire users and consumers to understand the power of this model. Also, we will see a stronger tendency of entrepreneurship becoming a public-private kind of association (as is already visible in Corporate Social Responsibility missions).

As this is the shape of future innovations which are likely to drive "the next wave", we can see a large number of policy questions coming. Some of these questions are there already, but will be intensified. How will this kind of "socialised innovations" affect economic growth and how do we measure their impact? How to balance widely accepted standards for platforms with bottom-up entrepreneurial, creativity and individual experiences driven innovations (e.g. Pine and Gilmore, 1999, Jacobs, 2014)? Who owns innovations and who reaps the benefits in this fully networked environment? How can research and innovation become more transparent and accessible for the wider public? What are the implications for our research and innovation institutions? What are individuals allowed to do with the new tools and in how far may public controls be needed? Etc. On most of these questions thinking has only just started (e.g. Leadbeater, 2008, Green, 2007). But in the meantime, practices are also growing. For example, crowd sourcing has spread around the world, not only for product development and getting production started, but increasingly also for R&D.

To really 'innovate out of the crisis' and ignite a new growth wave based on tackling major societal challenges, we need to find answers to the questions raised above. Taking a rather optimistic view of the future, this paper pointed to three major interlinked trends in the field of innovation and innovation policy:

1. A move to stronger state interventionist thinking (e.g. Mazzucato 2013, Block 2011, Atkinson 2012, etc.).

2. A move to what we have called "socialisation of innovation" (e.g. Leadbeater, 2008, Green, 2007, Von Hippel, 2005).

3. A move to transformative (systems-)innovation (Geels, 2005, Grin, Rotmans and Schot, 2010 and many others)

And even if things turn out to follow less optimistic paths, e.g. because of rising populism, a strong de-globalisation tendency and anti-modernism in current politics, the nature of technological change forces innovation policy to change. And it forces innovation policy research to move to an agenda in which understanding the related dynamics of technological and social change is (again) central.

References

Atkinson, R.D. and S.J. Ezell (2012): Innovation Economics, the race for global advantage. Yale UP, New Haven.

Atkinson, R.D. (2014): The US government isn't friendly enough to big business. Forbes Opinion, 7/08/2014. (http://www.forbes.com/sites/realspin/2014/07/08/the-u-s-government-isnt-friendly-enough-to-big-business/)

Boldrin, M. and Levine, D. K. (2008): Against intellectual monopoly, Cambridge University Press.

Block, F and M.R. Keller (Eds.) (2011): State of innovation, The U.S. Government's role in technology development. Paradigm Publishers, Boulder.

Castells, M. (1996): The Information Age: Economy, Society, and Culture (3 Volumes), Oxford, England, and Cambridge, Massachusetts: Blackwell Publishers.

Elg, L. (2014): Innovations and New Technology – What is the Role of Research? Implications for public Policy, Vinnova Analysis VA 2014:05.

Elg, L. and J. Leijten (Eds.) (2010) New Economic Ground for Innovation Policy, Cultivalibros, Coleccion Estudios. Número 143.

Florida, R. (2005): The world is spiky. The Atlantic Monthly, October.

Foray, D., P.A. David and B.H. Hall (2009): Smart Specialization, the concept. Knowledge Economists Policy Brief No. 9, June 2009, 5 pp.

Freeman, C and F. Louçã (2001): As time goes by, from the industrial revolutions to the information revolution. Oxford UP.

Geels, F.W. (2005) Technological transitions and system innovations: a co-evolutionary and socio-technical analysis; Edward Elgar Publishing

Giddens, A. (2009): The politics of climate change. Polity, Cambridge.

Godin, B. (2008) Innovation: The History of a Category, Project on the Intellectual History of Innovation Working Paper No. 1, 2008.

Green, J. (2007): Democratizing the future, Towards a new era of creativity and growth. Eindhoven, Philips.

Grin, J., J. Rotmans and J. Schot (2010): Transitions to sustainable development, new directions in the study of long term transformative change. New York/London, Routledge.

Hyytinen, K., Kivisaari, S., Lehtoranta, O., Lima Toivanen, M., Loikkanen, T. Lyytinen, T., Oksanen, J., Rilla, N., and R. van der Have (2012). Funder, activator, networker, investor...: exploring the roles of Tekes in fuelling Finnish innovation, Tekes Review 289/2012.

Jacobs, D. (2014): The Cultural Side of Innovation, adding values. Routledge.

Leadbeater, C. (2008) We-think, Mass innovation, not mass production. London, Profile Books.

Loikkanen, T., Rilla, N., Deschryvere, M., Lehenkari, J., Oksanen, J., Hyvönen, J., van der Have, R. (2013). Roles, effectiveness and impacts of VTT. Towards broad-based impact monitoring of a Research and Technology Organisation. VTT Innovation Studies.

Lundvall, B-Å. (Ed.) (1992): National Systems of Innovation, Towards a Theory of Innovation and Interactive Learning, Pinter Publishers, London.

Martin, Ben R., (2012): The evolution of science policy and innovation studies. Research Policy, Elsevier, vol. 41(7), pages 1219-1239.

Montalvo, C. and J. Leijten (2015): Is the response to the climate change and energy challenge a model for the societal challenges approach to innovation? Intereconomics Review of European Economic Policy Vol. 50, Nr. 1 January/February.

Mazzucato, M. (2013): The Entrepreneurial State. Anthem Press: London, UK.

Ohmae K. (2005): The Next Global State: Challenges and Opportunities in our Borderless World, Wharton School Publishing, Upper Saddle River, NJ.

Pappas, A. (2013): App Economy Forecasts 2013-2016, VisionMobile. (http://www.developereconomics.com/reports/app-economy-forecasts-2013-2016/#insights).

Perez C. (2016): Capitalism, Technology and a Green Global Golden Age: The Role of History in Helping to Shape the Future; in M. Jacobs and M. Mazzucato (eds) (2016): Rethinking Capitalism: Economics and Policy for Sustainable and Inclusive Growth, Wiley-Blackwell.

Pine, J. and Gilmore, J. (1999): The Experience Economy, Harvard Business School Press, Boston.

Prahalad, C.K. and V. Ramaswamy (2004): The Future of Competition: Co-creating Unique Value with Customers. Cambridge (Mass) Harvard Business.

Saunders, T and G. Mulgan (2017): Governing with Collective Intelligence; NESTA (nesta.org.uk).

Squicciarini, M. and Loikkanen, T. (Eds.) (2008) Going Global – The Challenges for Knowledge-Based Economies, Publications of the Ministry of Employment and the Economy, Innovation 20/2008 (sponsored by the DG Enterprise of the EU and the Ministry of Employment and the Economy of Finland).

Van der Giessen, A., C. Stolwijk, and J. Leijten (Eds.) (2015) Can policy follow the dynamics of global innovation platforms? Papers from a 6CP conference 14-15 April 2014, Stedelijk Museum's-Hertogenbosch, the Netherlands. Downloadable from http://www.6cp.net/

Von Hippel, E. (2005) Democratizing Innovation. Cambridge (Mass), MIT Press.

Appendix: summary table of post-war science, technology and innovation policy

Table 1 is an attempt to capture the main characteristics of the phases of science, technology and innovation (STI) policies in industrialized economies since the World War II until today. The table is based on and completed from earlier contributions on the evolution of the characteristics of public science, technology and innovation policies by Rothwell and Dodgson (1992), Caracostas and Muldur (1997), and Freeman and Soete (1999).

The table follows by and large the logic of the article above, starting from important contributions of Bernal in late 1930s and Vannevar Bush in the 1940s to the early research on the social functions of science. After the "Golden Age" of economic growth from the early 1950s, in the late 1960s and in the early 1970s an awareness arose of negative effects of technologies on the environment. Important manifestations in this development were the oil crises in early 1970s and the publication The Limits to Growth by the Club of Rome (Meadows et al. 1972). Since the late 1980s and in the 1990s, the awareness of the actual and potential threats of technological change to social and ecological development increased in industrialized countries. Social problems, especially unemployment, and ecological problems (particularly the depletion of ozone layer) became severe. Accordingly, in STI policies increasing attention was devoted to social and ecological issues, for example, to social embedding of technologies, integration of social and environmental issues into R&D, social innovations, and interactive learning. A remarkable element of the STI policies was the global perspective or "the techno-globalism" as characterized by the OECD in 1991. Another important issue was the necessity to integrate an ecological dimension into STI policy-making, which was a challenge to the rules of the game under which national and multinational companies operated. Strategic priority setting, the identification of core technologies, and the assessment of techno–economic strengths of industries, played key roles in the short and long term STI policy-making.

What was the impact of STI policies in the promotion of innovation activities? According to Henry Ergas (1987) the policies in Western economies were of a facilitating nature rather than based on strong explanation. The critical variables lie in how industry responds to the results and signals of efforts to upgrade national technological capabilities. This, in turn, will depend to a large extent on the environment in which industry operates. According to Freeman and Soete (1999) the national environment can have a considerable impact by stimulating and facilitating, but also by hindering or even preventing the innovative activities of firms.

The evolution of the characteristics of past, current and foreseeable developments in public science, innovation and technology policies have been compiled in Table 1 below, containing six sub-tables detailing different areas. Since the contributions of Rothwell and Dodgson (1992), Caracostas and Muldur (1997) and Freeman and Soete (1999) the interest in the corresponding overarching analysis about up-dating the phases of the scientific analysis of STI policies has been relatively low. Ben Martin´s analysis of the evolution of science policy and innovation studies (2012) is among the most analytical contributions in the field. Countries and regions naturally have essential differences in the past development of their STI policies. For example, Rothwell and Dodgson (1992) concluded in the early 1990s that Japan had a coordinated policy towards the acquisition of technology, the USA was driven by "market-pulled" innovation, and Western Europe had a long tradition in scientific research.

In STI expenditures, the big expansion occurred from in the 1940s and 1950s and after that followed a continued but slower expansion in the 1960s and 1970s. Then followed a levelling-off in the 1980s and 1990s and sometimes even a reduction of STI expenditures. With respect to this development, Sub-table 1 describes strategic economic issues with respect to STI, such as the developments in the economic environment, the changing role of state, objectives and main determining factors of STI, types of policy, the

geographical scale of policy, ministerial leadership, coordination and integration in policy-making, and emphases in the economic rationale for STI policies. Sub-table 2 illustrates trends and developments in STI policy implementation, e.g. forms of policy, trends and methods in public R&D funding, methods in R&D project and program assessment, principal selection criteria, and the nature of policy measures and instruments. Sub-table 3 illustrates trends and developments in evaluation and impact assessment of R&D and STI policies, such as the scope of evaluation, timing of evaluation, and evaluation and impact assessment procedures. Sub-table 4 describes techno-economic trends and developments in businesses and industries, for example, the emphasis of STI policies on industries, dominant industrial areas, organization and management trends in firms and production, and in R&D and innovation respectively. Sub-table 5 illustrates trends and developments in R&D, technological change and innovation, e.g. such as characteristics and stages of R&D, model of research and R&D process, nature and determination of priorities, main funded technology areas, nature of innovations and of R&D work. Finally, Sub-table 6 describes the primary sources of inspiration of STI in general and the main sources and contributions in the economic analysis of STI and STI policies in particular.

Among the relatively recent notions coming also to the STI policy literature is "ecosystem", used first in the business management literature by Moore (1993). The notion of ecosystem has increasingly been used in STI policy debates since the early 2000s. For example, the OECD also has become interested in analysing the concept in the context of STI policies (Mason and Brown 2013). STI in developing economies is a growing issue in the development models of low income countries and a relatively new issue in the STI literature. It is included in the tables below. Among the related sources are Prahalad (2006) and Mason and Brown (2013). The related literature is growing very fast today.

	- - 1950 - - 1970 - - 1975 - -	- - 1975 - - 1985 - - 95 - -
Sub-Table 1. DEVELOPMENTS IN STRATEGIC ISSUES OF SCIENCE, TECHNOLOGY AND INNOVATION		
Developments of economic environment	"Golden age" of economic growth Importance of national policy & regulation & protection, state owned companies Gradual growing influence of Japanese techno-economic development	Oil crises, recession, "Euro sclerosis". De-industrialization - to re-industrialization Gradual shift towards economic liberalization, economic integration (EU) Gradually increasing techno-economic importance of NICs, their recession 1997-
Role of the state	Central actor in technological research and innovation process	Towards decreasing role of the state, removal of regulative structures
Objectives of STI policies	Political, economic Space research, US-USSR competition	Economic (stability), increasingly social, organizational, institutional & environmental Technology Assessment
Main determining & guiding factors of STI policies	Defense, economic growth, productivity Mission oriented policy	Industrial competitiveness, energy efficiency, renewal of industrial structure toward diversification, information society
Policy type	Direct control	Towards context control SMEs
Geographical scale	Mainly national	Growing internationalization Growing role of regions within nations
Ministerial leadership & coordination & integration	Defense, education & research Science advisory councils Part of economic & science policy, implicit R&D policy. Little coordination	Education & research & industrial Science & technology advisory councils Gradually to independent STI policies field Increasing coordination
Economic justification of public STI funding	STI effects to welfare, market failure (inadequate basic research from society´s perspective), STI infrastructure (energy, transportation, communication...) Areas of critical mass (space, aeronautical)	Market failure + government & policy failures Areas of critical mass and long time horizon R&D schemes for SMEs. Environmental damages (negative externalities)

	- - 1995 - - 2000 - - 2005 - -	- - 2005 onwards
(STI) POLICIES		
	Growing global importance of ICT, technology based companies, Nasdaq Escalation of global financial markets, Collapse of IT stock exchange ("Bubble") 2001-2002, Rise of emerging Asian economies China and India, other BRICs Climate Change	Globalization (economies, ICT, media) Global climate change Economic recession and the Era of austerity in industrialized economies since 2008-2009 - 2107
	Facilitator and coordinator of the self-regulation of innovation	Growing trend of neo-liberalization, towards entrepreneurial state
	Economic, social, cultural, organizational, institutional & environmental Towards ethical and social responsibility Promotion of ´Porterian´ industrial clusters	Innovation instead of technology policy Expansion of scope of innovation (social, behavioral, etc.) Solutions to Grand socio-economic Challenges, long-term transformations
	Techno-economic competitiveness, employment & quality of life, social & environmental compatibility Raising awareness of STI policies in developing economies	Cuts of STI expenditures in the Era of austerity since 2008/09 - Evidence based STI policies
	Context control, favorable environment & conditions providing policy, strengthen firms´ absorptive capacity to apply new knowledge, SMEs	Neo-liberalization => aspirations towards de-regulation Public procurement driven innovation Regulation driven innovation
	Techno-economic globalization of industrialized & industrializing economies; Growing role of cross-border regions (EU)	Global perspective, still national borders matter
	Explicit technology policy Inter-ministerial co-operation and co-ordination, recognition of the need towards horizontal policies	In the era of austerity a gradual shifts from STI policies (back) towards industrial policy
	Market + government + system failures Innovation network externalities Environmental damages, climate change in particular	Grand Challenges driven and evidence based legitimacy (EU 2006) Market + government + system + transformational failures

	- - 1950 - - 1970 - - 1975 - -	- - 1975 - - 1985 - - 95 - -
Sub-Table 2. DEVELOPMENTS IN STI POLICY IMPLEMENTATION		
Policy forms	Universities & other government research labs & bodies, public & private contract research organizations (CROs)	Towards (national) innovation system thinking Incentive programs, promotion of cooperation
Trends and methods of public STI funding	Big expansion of STI expenditures Administrative arrangements	Levelling off of public STI funding Techno-administrative
Methods of STI project & program assessment	OECD Frascati conference in 1963 ST indicators => Frascati (& Oslo) manual Scientific assessment by peers	Scientific assessment by peers & users, STI foresight
Principal selection criteria	Scientific excellence	Scientific excellence & contribution to competitiveness & welfare
Policy instruments	STI subsidies, regulation, patent system	STI subsidies, provision of infrastructure, R&D programs, taxation, public procurement, technology transfer schemes, incubating activities, pilot & prototypes, liaison offices, public and private venture capital
Nature of measures & instruments	Basic R&D centered on spillover	Pre-competitive R&D and indirect support for innovation

	- - 1995 - - 2000 - - 2005 - -	- - 2005 onwards
	Task forces, interdisciplinary programs & projects	Encouragement of entrepreneurial activities, start-ups, venture capital, crowd funding
	Diversified development in public STI funding Techno-financial	Grand challenges, renewal of industrial structures
	Integrated assessment of financial aspects & socio-economic & environmental impact, and STI foresights, technology road-mapping	Ex-post and ex-ante evaluation and impact assessment, transformational perspective
	Contribution to needs of society, industry & environment, increasing private venture capital	Priorities supported by foresight, ex-post and ex-ante impact assessment
	R&D subsidies, incubating activities, promotion of innovation networks, rewards, prizes Promotion of young high-growth firms, SMEs	Promotion of entrepreneurial activities, start-ups, venture capital, crowd funding Towards integration of promotion of innovation and business developments
	Targeted R&D (incl. socio-economic aspects) up to commercialization of innovations	Encouragement of entrepreneurial activities Solutions to Grand Challenges

	- - 1950 - - 1970 - - 1975 - -	- - 1975 - - 1985 - - 95 - -
Sub-Table 3. DEVELOPMENTS IN EVALUATION & ASSESSMENT OF R&D AND		
Scope of evaluation	Evaluation of scientific impact (perhaps) of research projects	Extension of evaluation to scientific & technical impact of projects, programs
Timing of evaluation	Ex-post evaluation	Ex-post & gradual ex-ante and intermediate ("on-line") evaluation
Procedure	Occasional	Gradually towards professional & systemic practices

	- - 1950 - - 1970 - - 1975 - -	- - 1975 - - 1985 - - 95 - -
Sub-Table 4. TECHNO-ECONOMIC DEVELOPMENTS OF COMPANIES & INDUSTRIES		
Emphasis of technology policy in industries	Large industrial firms, industrial agglomerations, state owned companies, national "flagships"	Large industrial firms & increasing interest in innovative SMEs Growing importance of cooperation & industrial clusters
Dominant industrial areas	Energy (systems), chemical, metal, manufacturing, building	Automation, information and communication technologies (ICT)
Firm & production organization & management	Hierarchical, top-down, command & control "Fordist" production systems	Lean organization, JOT, FMS, reversed & concurrent engineering, Toyotism
R&D and innovation management & organization	Separate R&D units, weak linkage between R&D and other firm activities	Out-sourcing of R&D, acquisition of external R&D services, integration of R&D with company activities & concurrent engineering, road mapping, user-producer linkages

- - 1995 - - 2000 - - 2005 - -	- - 2005 onwards
(STI) POLICIES	
On-going evaluation of socio-economic and environmental impacts of projects, programs, institutes, policy programs, towards ethical (perhaps)	Grand Challenges based long-term perspective in evaluation and impact assessment
Integrated ex-ante & foresight & ex-post technology assessment & STI evaluation	Towards transformational ex-post and ex-ante evaluation and impact assessment
Professional & systematic practices	Systematic evaluation and impact assessment

- - 1995 - - 2000 - - 2005 - -	- - 2005 onwards
Large industrial firms & service companies & high growth SMEs & new technology based firms (NTBFs) Globalizing company networks & business value chains Industrial clusters	Global large multinationals, start-up firms, global value chains
ICT, bio & gene, environmental, alternative energy, welfare technology, nano technology	Digitalization, Artificial Intelligence (AI), Industrial Internet, “Industry 4”, robots, Non-fossil energy & electricity, Bio-economy, health
Lean interactive and participatory work organization, motivation	Value chain management Towards remote control of production operations and maintenance (O&M), services
Interactive and integrated R&D, techno-economic competitiveness, strengthen absorptive capacity to apply new knowledge Globalization, global R&D strategies	Value chain organization & management of innovation User engagement in innovation Opening innovation Frugal innovation

	- - 1950 - - 1970 - - 1975 - -	- - 1975 - - 1985 - - 95 - -
Sub-Table 5. DEVELOPMENTS OF R&D, TECHNOLOGICAL CHANGE, INNOVATION		
Characteristics & stages of R&D	Basic & fundamental Science push Little bearing on markets	Growing interest in applied R&D and technology dissemination & transfer Closer to the market, demand pull
Model of research and R&D process	Linear from R&D investment to rates of return of R&D	From linear towards complex, growing emphasis on creation & dissemination
Nature & determination of priorities	Politico-scientific, top-down	Techno-industrial, shift from top-down to bottom-up
Main funded technology areas	Large scale nuclear, military, aeronautical, physics, chemistry	Energy, civil aircraft, automation, electronics, computers, ICT economic & social aspects & studies
Nature of innovations	Radical technological innovations	Incremental technological innovations & gradual increase of social & organizational innovations
Nature of R&D work	Individual, researchers and labs separate to each other	Towards professional R&D work, cooperation of researchers and labs

	- - 1950 - - 1970 - - 1975 - -	- - 1975 - - 1985 - - 95 - -
Sub-Table 6. INSPIRATION SOURCES OF STI POLICIES AND ECONOMIC ANALYSIS OF STI		
Intellectual and other inspirations	D.J. Bernal (1939), Vannevar Bush (1945), OECD 1963, OECD 1971 (The Brooks Report)	Japanese VLSI & 5th generation computer programs The Brundtland Report on Sustainable Development, OECD (1979, 1991, 1994, 1990), National Innovation System, social shaping of technology,
Selected contributions to the economic analysis of technology policy	Nelson (1959), Solow (1957), Arrow (1961), Mansfield (1965)	Dasgupta and Stiglitz (1981), Rosenberg (1982), Rothwell and Zegveld (1981), Freeman (1982), Nelson and Winter (1982), Averch (1985), Freeman (1987), Stoneman (1987), Dosi et al. (1988), Lundvall (1992), Lundvall (1992), Nelson (Ed.) (1993), Metcalfe (1993), Porter (1990)

- - 1995 - - 2000 - - 2005 - -	- - 2005 onwards
Integration of basic - applied R&D & dissemination of R&D results Demand & market oriented From tangibles to intangibles	Demand, customer and user driven innovation process Public innovation, public procurement Multi-Level Perspective (MLP) model, Transition Management model
Complex, interactive and systemic innovation process	Complex long-term global problem solving, transitional / transformational policies, Multi-Level Perspective (MLP) model, Transition Management model
Socio-political, integrated top down & bottom-up	Grand Challenges driven long-term priorities
ICT, materials, bio & gene technologies Hybrid & generic science & technologies, combined to address specific economic, social and environmental problems; health technology, nano technology; technological fusion	Grand Challenges driven themes Sustainable non-fossil energy & electricity (fusion, ITER, renewables, wind, solar, bio-energy, renaissance of nuclear, digitalization, Artificial Intelligence (AI), Industrial Internet, "Industry 4", robots, Bio-economy, health
Technological and social innovations Diffusion of innovations	Social (behavioral, management, organizational, business...) innovations, public innovations Service innovation
Professional & integrated R&D and production systems	Multi / interdisciplinary incl. social and human sciences

- - 1995 - - 2000 - - 2005 - -	- - 2005 onwards
POLICIES	
Innovation system, "Mode 2" of knowledge production, Kyoto Protocol and Post-Kioto perspectives, System transition (transformation), (New phase of) globalization & emerging economies, 9/11 & homeland security	Grand Challenges (EU strategy 2006) Growing importance of ecosystem thinking in literature, platform economies Gazelle companies, fast growth companies
Metcalfe (1995), OECD (1998), Freeman and Soete (1999), Gibbons et al (1994), OECD STI Review No. 22 (1997), Research Policy Vol. 29, April 2000, Christensen (1997), Aghion Aho report (2006), Prahalad (2005), Georghiou et al. (2006), Kraemer-Mbula and Wamae (Eds.) (2010)	Moore (1993), Von Hippel (1999), Chesbrough (2003), Georghiou et al. (2006), Mazzucato (2014)

Sources

Aho report (2006) Aho Group Report "Creating an Innovative Europe", Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit and chaired by Mr. Esko Aho, January 2006, EUR 22005.

Arrow, K.J. (1962) Economic Welfare and the Allocation of Resources for Invention, in: The Rate and Direction of Inventive Activity Princeton: Princeton University Press) (1962) 609-625, and republished in: The Economics of Technological Change, ed. N. Rosenberg, Harmondsworth, 1971, ss.164-181; and in: The Economics of Information and Knowledge (ed. J. Lamberton, Harmondsworth, 1971, ss. 141-159).

Averch, H.A. (1986) A Strategic Analysis of Science and Technology Policy, The Johns Hopkins University Press, Baltimore and London.

Bernal, J.D. (1939) The Social Function of Science, Routledge and Kegan Paul.

Bush, V. (1945) Science The Endless Frontier. A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945.

Caracostas, P. and Muldur, U. (1998) Society, the Endless Frontier, A European Vision of Research and Innovation Policies for the 21st Century, European Commission, DG XII.

Chesbrough, H.W. (2003) The era of open innovation. MIT Sloan Management Review 44(3), 3 5–41.

Christensen, C.M. (1997) The Innovator´s dilemma, Collins Business Essentials.

Dasgupta, P. and Stiglitz, J. (1980) Uncertainty, Industrial Structure and the Speed of R&D, Bell Journal of Economics 11/1980, 1–28.

Dasgupta and Stoneman (Eds.) (1987) Economic policy and technological performance, Cambridge University Press.

Dosi, G. et al. (1988) Technical Change and Economic Theory, Pinter Publishers.

Ergas, H. (1987) The importance of technology policy, in: Economic policy and technological performance, in Dasgupta and Stoneman (Eds.).

European Commission (2008) Challenging Europe's Research: Rationales for the European Research Area (ERA), Report of the ERA Expert Group, European Commission, Directorate-General for Research.

Freeman, C. (1982) The Economics of Industrial Innovation, 2nd Edition, Frances Pinter (Publishers), London.

Freeman, C. (1987) Technology Policy and Economic Performance, Lessons from Japan, Pinter Publishers

Freeman, C. and Soete, L. (1999) The Economics of Industrial Innovation, Third Edition, Pinter.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994) The New Production of Knowledge, The Dynamics of Science and Research in Contemporary Societies, SAGE Publications.

Kraemer-Mbula, E. and W. Wamae (Eds.) (2010) Innovation and the Development Agenda, International Development Research Centre, ISRC/OECD.

Mansfield, E. (1965) Rates of Return from Industrial Research and Development, American Economic Review, 55, pp. 310-322.

Lundvall, B-A. (Ed.) (1992) National Systems of Innovation, Towards A Theory of Innovation and Interactive Learning, Pinter Publishers, London.

Martin, Ben R., (2012): The evolution of science policy and innovation studies. Research Policy, Elsevier, vol. 41(7), pages 1219-1239.

Mason, C. and R. Brown (2013) Entrepreneurial Ecosystems and Growth oriented Entrepreneurship, Background paper prepared for the workshop organised by the OECD LEED Programme and the Dutch Ministry of Economic Affairs on Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship, The Hague, Netherlands.

Mazzucato, M. (2014) The Entrepreneurial State. Debunking Public vs. Private Sector Myths. Revised Edition. PublicAffairs, New York.

Meadows et al. (1972) Limits of Growth, Universe Books. NEW YORK.

Metcalfe, J.S. (1995) The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives, in Stoneman, P. (Ed) Handbook of the Economics of Innovation and Technological Change, Blackwell Handbooks in Economics, Blackwell, 408–512.

Moore, J.F. (1993) Predators and prey: a new ecology of competition, Harvard Business Review 71 (3): 75–86.

Nelson, R.R. 1959 The Simple Economics of Basic Scientific Research, Journal of Political Economy, 297-306.

Nelson, R.R. (Ed.) (1993) National Innovation Systems, A Comparative Analysis. Oxford University Press.

Nelson, R.R. and S. Winter (1982) An Evolutionary Theory of Economic Change, The Belknap Press of Harvard University Press.

OECD (1998), "New Rationale and Approaches in Technology and Innovation Policy", STI Review, 22. Paris: OECD.

Porter, M. (1990) The Competitive Advantage of Nations. New York: Free Press.

Prahalad, C.K. (2005) The Fortune at the Bottom of the Pyramid, Eradicating Poverty Through Profits, Wharton Business School Publishing.

Research Policy Vol. 29, April 2000, Special Issue: The Economics of Technology Policy.

Rothwell, R. and M. Dodgson (1992) European technology policy evolution: convergence towards SMEs and regional technology transfer, Technovation, 12 (4), 223-238.

Rothwell, R. and Zegveld, W. (1981) Industrial Innovation and Public Policy, London, Pinter Publishers.

Rosenberg, N. (1982) Inside the Black Box, Cambridge, Cambridge University Press.

Solow, R.M. (1957) Technical Progress and the Aggregate Production Function, Review of Economics and Statistics, vol. 39, 312-20.

Stoneman, P. (1987) The Economic Analysis of Technology Policy, Clarendon Press.

Von Hippel, E. (2005) Democratisation of Innovation, The MIT Press.

The Zegveld Agenda 50 Years After

From successful diffusion of innovation to toothless government science

Frits Prakke[14]

I first met Walter in 1973 as a visitor to the Cambridge office of my then boss Herbert Hollomon. I was a research assistant working on international comparison of innovation policies. Hollomon was director of the Center for Policy Alternatives at the MIT School of Engineering, the outspoken leader of an anti-establishment think tank, and a fighter. As a former Assistant Secretary of Commerce and liaison with the Pentagon he had a history of fighting government waste**.** As a responsible engineer, he fought corruption in military procurement and exposed scandals in environmental protection (the Love Canal). It was the time of the Vietnam war. Herbert was not afraid to point out to the generals that he would have preferred Ho Chi Min as American partner over the corrupt South-Vietnamese.

As a maverick, as an outsider, Hollomon was fighting the mighty MIT Engineering School establishment for being subservient to Big Industry in the US. His theory of dominant factors in industrial innovation was Demand Pull rather than the popular Technology Push. He was fighting – and expertly lobbying – the National Science Foundation and other funding agencies for more money and for academic status of his multidisciplinary research team. Hollomon hoped to use Zegveld to get funding from European governments for MIT's research on innovation policies. Zegveld in turn used the prestige of Hollomon to get funding for his new institute at TNO.

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14 Frits Prakke worked in the field of innovation management at TNO and MERIT.

Hollomon pointed out to Zegveld the exciting impact HiTech start-ups were making on new technology and on industrial revival in Massachusetts. That was in 1973 the phenomenon of "Route 128" HiTech ventures, strong regional technical innovation in small firms centered on a world class university, similar to Silicon Valley in California. This was seen as the failure of large multinationals and as diffusion of innovation. The researchers of the MIT Center for Policy Alternatives were also pioneers in Technology Assessment. In particular they studied the effects of technical innovation on the quantity and quality of labour, the neglect of the risks and costs of nuclear power, and the failure of environmental regulations. The MIT research on World Dynamics was the base of the epoch-making report of the Club of Rome, which was a major shock to the global industrial establishment in 1972.

Walter Zegveld was very impressed by Herbert Hollomon, in whom he found a kindred spiritness. As a new addition to his TNO team, I became more and more impressed in the following years by the passion and efforts of Walter. As an outsider to the conservative Dutch engineering establishments, he worked to translate the ideas on innovation of Hollomon at MIT to the Netherlands. The Six Countries Programme was instrumental in spreading this, what I will call, *Zegveld Agenda* for innovation in Europe. Using the TNO Center for Technology Policy and its independent analysts as his base, Walter Zegveld pioneered research on innovation in the Netherlands, in particular on the importance of *demand pull* and *technology assessment*. He fought against the misuse of subsidies for R&D as generic tax breaks for ailing industry. As a former star salesman of military aircraft he became an influential critic of the military-industrial complex. As a former marketing director of TNO nuclear research, he came to lead the charge against wasteful subsidies for nuclear power. TNO under his direction became a leader in research on Future Studies and Technology Assessment, more in particular on the effects of automation and robotics on labour and research on environmental protection policies. But Zegveld's

greatest success probably came in designing policies for stimulating the *diffusion of innovation* in start-ups and small and medium sized firms.

Start-ups

In 1979 the phenomenon of networked HiTech start-ups – like Silicon Valley and the Rte. 128 firms around Boston - was non-existent in the Netherlands. The minister of Economic affairs gave Zegveld and TNO six months and $100.000 dollars to do the empirical research. On their first assignment at TNO, Prakke and Hagedoorn investigated spinoffs from AKZO, Shell and Philips and interviewed scores of Delft and Leiden professors. They found only a handful of examples. No more than five. US-style venture capital was unknown. We went back to the Minister and he was not pleased. In a time honoured tradition of policy researchers we asked for more money and agreed to widen the definition of HiTech. This resulted, after searching for almost a full year, in the number of 42 Hi-tech start-ups in the Netherlands in 1979.

This was the starting point of decades of efforts by the Ministry of Economic Affairs, and a new institute at TNO, Project Industrial Innovation, under the guidance of Zegveld, to stimulate technical innovation and entrepreneurship in small firms. A network of Innovation Consultants was created. As a counterweight to decades of lavish subsidies for R&D in large Dutch multinationals the decision was made to subsidize the diffusion of innovation and the spreading of innovation capacities to small firms and to all regions. Compared to the situation in 1979 this has truly been a revolution. Call it the *Zegveld Revolution*. Programs for regional innovation networks (eg RITTS) have since been financed by the European Commission throughout Europe. Traditionally every Dutch town has one Catholic church and two or three Protestant churches. In 2016 there are fewer churches, but hardly a Dutch town can be found without its Brain Park. Every Dutch university prides itself on educating entrepreneurs and produc-

ing start-ups. We have a disturbing excess of venture capital chasing start-ups. The world-famous Philips R&D lab in Eindhoven, the Natlab, since 1928 the source of some of the most exciting innovations of the 20th century (world leading radar in the thirties, audio and video breakthroughs in the fifties, car navigation before the market was ready in the nineties), this Philips Natlab now has largely been replaced by an open innovation campus, where start-ups can rent space and share coffee machines.

The increase of subsidies for diffusion of innovation to small firms and regional networks, at the expense of generic R&D subsidies for multinationals, was also seen in circles of economists as a victory of Evolutionary Economics over traditional Neo-classical Economics. I am not sure if Nicholas Ashford, John Hagedoorn and Luc Soete, participating in today's workshop, would agree with me on this. Either way, as was pointed out by Evert-Jan Velzing (2013) in his dissertation on Innovation Politics (funded by a Dutch lobby organization for midsize manufacturers, SIC), behind every academic debate on innovation research, very real, opposing economic interests play out. Countervailing power in market relationships has a parallel in countervailing power in seemingly academic policy debates.

By the way, this was a playing field on which Walter Zegveld was a star player. He never hesitated to fight the Dutch engineering establishment or even the vested Dutch economics establishment. To defend the *Zegveld Agenda* he cultivated allies at key positions at the Ministries and at universities. Not for the sake of his career, but for the sake of his agenda. He fought for his own team, a financially independent TNO Center for Technology Policy Studies. Over twenty years this grew to be a dominant policy research institute of more than 50 academics, many of the highest level. As a true democrat Zegveld also worked hard for transparency and the independence of other public research institutes. I mention the Rathenau Institute, where he was chairman, the WRR, Merit, where Walter was an early booster, Nipo-TNO, AWTI, SCPB, RIVM and privacy watchdogs, to name just a few. Internationally we have the OECD and the 6CP (hats off!) as inde-

pendent research institutes and fighters for the necessary countervailing power in policy research. All of these institutes are dependent on outside funding and must fight to keep their independence from the industrial sectors or government departments they are designed to monitor. They are an endangered species in times of privatisation. They should not be replaced by pay-to-play consultant firms or in-house government agencies. The 2016 scandal of an in-house EU environmental watchdog checking on Volkswagen diesel emissions is an example of failing countervailing power in research institutes.

What remains of the *Zegveld Agenda* of 1975? If we concede victory points to demand pull and user orientation in engineering education and in the newly dominant ICT sector, and to the diffusion of innovation to (networks of) small firms, many points of concern remain.

The unfinished agenda

First, I think that Walter would be very disappointed in the present weakness of independent public science and technology institutes to match and to provide a check on the superior knowledge positions of private industry. He would point out that there is a serious lack of expertise in the public domain and a lack of willingness to speak truth to power. The debate on climate change has drawn attention to the deniers of science (about global warming) in recent years, but there are many equally disturbing cases of disregarding science in favour of short term economic interests. At critical Dutch ministries scientists and engineers have become vastly outnumbered by public affairs experts. Public scientists and engineers and their poorly funded institutes in Europe have failed to act on the Volkswagen software fraud with respect to diesel emissions. The technical ineptitude of government has led to a billion-euro misuse of tax payer's money in the procurement of the Fyra high speed trains. Fraud in pinstripes at the banks, leading to the mortgage crisis of 2008, has been matched by fraud in white coats in the laboratories of major chemical

and pharmaceutical companies. The results have been billions of government resources wasted, major environmental disasters and drug pricing scandals. Regulatory agencies have in twenty years fallen behind in their countervailing power against private industry, as independent science and engineering institutes have fallen behind in their countervailing positions of expertise. Science has been losing major battles on both sides of the ocean long before the Trump administration in America embraced alternative truths and declared its "war on science".

I always marvelled at Walter Zegveld's ability to translate a newspaper story into an urgent public policy issue, and of course, into an opportunity for our TNO group to launch a new research project. I believe Walter would seriously scratch his head at the news in the December 2016 newspapers about the failure of government engineers and economists to correctly assess the costs of offshore wind power parks in the North Sea. Consider this:

March 2016: Budget for offshore wind power parks in the North Sea in the best estimate of the Dutch government economists: € 18 billion

December 2016: Final contracts for the realization in 2020 by Shell and others of the exact same wind power parks: € 6 billion

Somebody at Shell and the power companies has been extremely good at hiding 12 billion euros of excess profits at the expense of the tax payer. Or somebody has been very, very stupid. Walter, having worked at Shell as a young engineer might have known the answer. And have given his famous grin. I also worry about the decision made in 2011 by the Dutch Minister of the Environment, Jacqueline Cramer, a dear former colleague at TNO-CTPS, to allow – and subsidize in the name of sustainability and CO2 reduction – the building of three new coalfired power plants. Was she advised by the same group of government economists who calculated the costs estimate for offshore wind power? Who paid for that? Was a review done by independent engineering experts? Should this lack of public expertise in the

area of energy systems be an urgent call to launch a new policy research program at TNO, or the 6CP? What would Walter say?

In parting I have a final personal point of concern. That is the abandonment of interest in the effects of technology on labour. The effects of robots on middle class employment is a regular topic in today's newspapers, but not so much at our workshop in the Koninklijke Schouwburg in The Hague. Freeman and Soete did the economic research on employment and technology in the 1980's at SPRU. We are now in the New Economy. In this new era, I particularly worry about the effects of information and communication technology on the quality of labour and the quality of management practices (Prakke, 2014). This was a major issue at MIT and at TNO in 1975, but was neglected later on, due to the lack of outside interest. In the spirit of determining at this workshop the newly emerging urgent issues – as Walter would have done – I believe we should have a radical new look at the issue of technology and labour in 2017.

References:

Prakke, F. 'Science and Technology Insights' at: fritsprakke.com

Velzing, E.J. (2013) Innovatiepolitiek 1976- 2010. Eburon

Prakke, F. (2014) DE GELUKKIGE ONDERNEMING, Arbeidsverhoudingen voor de 21ste eeuw. Hoofdstuk 13 (p. 155-175) Jaarboek voor de Sociaal-Democratie, Wiardi Beckman Stichting, Uitgeverij van Gennep

Walter Zegveld: engineer and practitioner

(in the world of Schumpeter, evolutionary economics, and management of innovation)

John Hagedoorn[15]

Introduction

To start off with a personal note, I was hired by Walter Zegveld's Group for Strategic Foresight at TNO in 1978. I was about to receive a dual degree in economic sociology and political economy. My thesis was about innovation and innovation policy from a neo-Marxist (Baran and Sweezy-like) perspective. Until I was hired most of my friends were worried if I would ever get a decent job. Interestingly, not because I was a neo-Marxist (somewhat lost in an academic scenery of neo-Keynesian and orthodox Marxist economists) but because I was interested in this obscure topic of 'innovation' that so few economists seemed to care about. Long story short: Walter turned out to be a very liberal person who had no problems with hiring a neo-Marxist interested in the empirical economic analysis of innovation. In all honesty, I also suspect that for Walter having a neo-Marxist in his team might have fallen under the heading 'every group needs a screwball'.

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Just a couple of years later, while still at TNO, I would already consider myself to be rather neo-Schumpeterian than neo-Marxist. And there lies the bridge to Walter's contribution to the analysis of innovation and economic development that I will focus on for the larger part of this chapter. If one label would apply to Walter's understanding of the role and importance of innovation, it is that this understanding is truly 'Schumpeterian' in nature.

In the following, I will assess the role that (neo-)Schumpeterian economics has played in Walter's contributions to the analysis of innovation through a variety of his publications. I will first discuss Walter's work that focused on a more general understanding of the role of innovation in economic development from a macro-economic perspective. This is followed by a further assessment of the role of innovation at the level of firms, i.e. the management of innovation, and some final remarks on the impact of Walter's writings.

Schumpeterian economics

Although Walter Zegveld has a considerable number of publications that fall within the realm of economics, his formal education was not in economics or any other of the social sciences. Walter was an engineer and like many engineers he had a very pragmatic approach, in this context, to the understanding of the role of innovation in economic development. After consulting a number of Walter's publications, I found it remarkable how many of his pragmatic insights regarding the importance of innovation, as presented in the late 1970s and early 1980s, when he published a number of books with Roy Rothwell, are still surprisingly relevant. Many of the 'new' topics that Roy and Walter discussed still feature prominently, both in the curricula of many business schools and in the innovation policy arena.

In terms of a general theoretical background, Joseph Schumpeter turned out to be a great inspiration for Walter's understanding of the economics of innovation. The fact that Walter was so inspired by Schumpeter is in it-

self already quite interesting. In the 1970s most of Schumpeter's work was seen by many economists as a mix of:

- the typical Austrian economics tradition of impracticability (Johnson, 1972) and

- what the famous British economist Lionel Robbins described as work based on 'a supremely intelligent after-dinner talk' (see Elster, 1983, p. 112).

However, starting in the 1970s, an increasing number of economists became interested in Schumpeter's more empirical work on innovation and economic development which lead to a neo-Schumpeterian revival. For Walter the Schumpeterian understanding of the relationship between innovation and economic development was all about its practical implications (and much more serious than any after-dinner talk, no matter how intelligent). In essence, it was all about getting a better understanding of technology, innovation and economic development, a relationship, that was treated by so many economists as a black box (Zegveld, 1987).

Although most of the Schumpeterian input into Walter's thoughts on innovation focused on the firm level and its implications for innovation policy, his writings with Roy Rothwell also referred to a more macro-economic perspective. This macro-economic perspective in Walter's publications followed a broad Schumpeterian understanding of economic development, inspired by the contributions of Chris Freeman and others (e.g. Freeman et al., 1982), where the economy follows a pattern of 50 plus years long waves, so called Kondratiev cycles, characterized by periods of prosperity, recession, depression, and recovery (Rothwell and Zegveld, 1985). In a sequence of Kondratiev cycles, the earlier cycle already contains the seeds of new growth options, i.e. new technologies that provide new growth opportunities. However, their potential value, in terms of new markets, new options,

and new products, is only recognized by a few (Rothwell and Zegveld, 1979). Once these new opportunities are recognized by a growing number of firms this creates a bandwagon effect and, due to a bunching of major innovations and increasing investments, new industries are created. Gradually, the effects of the depression wear off and economic growth picks up again and the economy finds itself in new period of upswing and prosperity.

Admittedly, this line of largely qualitative and descriptive economic analysis has lost most of its appeal with modern economists as, from a time-series econometric perspective, the analysis leaves, to put it mildly, much to be desired in terms of a clear econometric specification of growth cycles (and sub-periods). Theoretically, the analysis is still rather speculative and lacks a well-developed model that explains the intricate economic mechanisms behind these long-term growth cycles. So, this line of work follows the proverbial Schumpeterian 'painted with a broad brush' approach. However, for Walter the main point was not so much the detailed academic analysis of long-term economic cycles and long waves, based on a solid theory of economic growth, but rather the policy relevance of the recognition that new technological opportunities would be identified by entrepreneurs and that the greater and broader the impact of these technological opportunities, the greater the likelihood that new industries would emerge and grow (Rothwell and Zegveld, 1979, 1981 and 1985).

Practical implications of this line of work in Walter's contributions are that new industries are the main engines of long-term economic growth. In that context, new industries that were identified as engines of growth during the final decades of the previous century were mostly ICT related and energy, biotechnology and new materials based industries (Rothwell and Zegveld, 1985). These new industries were based on new technological trajectories that represent more general, long-term trends and pathways of technological change at the level of industries (Nelson and Winter, 1977). An important implication of this long-term perspective for innovation policy is that this policy should neither provide extensive support across the board of industries, nor should it be of a defensive nature, i.e. provide

support for mature industries that played a role in the previous long wave. Innovation policy should largely be offensive in nature. The main goal of innovation policy should be to create a selection environment, in which new industries and new firms can emerge, fail or grow and eventually prosper (Rothwell and Zegveld, 1985).

Management of innovation

Although the role of entrepreneurs was already stressed in the context of Kondratiev cycles as entrepreneurs are the economic agents of change who see the new opportunities for economic growth, the role of entrepreneurs in Walter's work is much more prominent in his understanding of the firm as an engine of economic growth. After re-reading a number of Walter's contributions from at least thirty years ago, I was surprised that so many topics that feature in these publications still seem to be very relevant. Moreover, these topics appear prominently in many business school advanced courses on strategic management and innovation management. For instance in a number of publications (e.g. Rothwell and Zegveld, 1985; Zegveld, 1987), Walter stressed the complementarity of small, entrepreneurial firms (the Schumpeter Mark I innovators) and large firms where innovation is systematically managed (Schumpeter Mark II innovators). These firms are seen as rather different, yet complementary, players that each play an important role in the current overall innovation landscape, unlike their role in Schumpeter's original categorization where their different roles referred primarily to different eras of capitalist development (Schumpeter, 1975 (1942)). Interestingly, that complementarity was also seen by Walter in terms of large firms being the successful breeding grounds for spin-offs and newly technology based firms (NTBFs) that, contrary to their 'parents', are involved in less-routinized, risky, innovative projects (Rothwell and Zegveld, 1982).

Walter considered these NTBFs as the key forces of innovation and the truly Schumpeterian entrepreneurial change agents. However, in an interesting Schumpeterian twist the role of entrepreneurship is not just important

in the context of NTBFs. Long before the debate about 'intrapreneurship' within large firms (e.g. Ahuja and Lampert, 2001), Walter highlighted how internal entrepreneurship within these large firms could become more important as firms recognize the crucial role of key innovators within the organization (Rothwell and Zegveld, 1982). In that context, firms have to develop not only a strategy to increase the role of these key innovators but they also have to enable key innovators (or at least some of them) to create new ventures. These new ventures can take the shape of either internal new ventures that operate at some arm-length or they become independent or semi-independent spin-offs.

Based on this understanding of what was labelled as the 'dynamic complementarities' between large, established firm and NTBFs, Walter was also one of the first to recognize the role of alliances and cooperation between firms in jointly generating innovative output (Zegveld, 1987). As such, he stressed the importance of both:

- inter-sectoral cooperation between firms from very different industries that jointly search for new products, processes, and opportunities, and

- the importance of large firm – small firm cooperative complementarity as their strengths and weaknesses could be balanced out in joint efforts and even create dynamic complementarities, where combining the activities of both firms, increases the output of each partner (see also Love et al, 2014).

Interestingly, Walter also stressed that the dynamic complementarities between these different categories did not materialize without overcoming some serious barriers for effective collaboration. This well-known problem is largely due to a range of major differences between large and small firms. Most of these differences are related to different company cultures and very different planning and managerial horizons that demand time-consuming efforts by both firms to effectively manage their cooperation (Zegveld, 1987).

Finally, although I don't think that Walter ever used the term 'user innovation' in his 1970s and 1980s publications, he did stress that in a more vertical setting of inter-firm cooperation, firms could benefit greatly from their collaboration with users (Zegveld, 1987). This vertical or user cooperation which is now frequently referred to as a cornerstone of open innovation (Chesbrough, 2003) was seen as an important input into the innovation strategy of firms as it increased their awareness of downstream innovation needs. In addition, vertical cooperation, between firms that are not or only to a limited degree operating in similar markets, enables both parties to share knowledge and streamline production and innovation inputs, as there is less concern about unintended knowledge leakage to competitors.

Concluding remarks

So, apart from the policy implications of much of Walter's work, I think it is important to recognize that Walter also had a keen understanding of new developments in the economics and management of innovation. As such, he played an important role in stressing the importance of innovation for firm growth (and for economic growth in general). Walter was one of the first to recognize the important innovative role of NTBFs and other entrepreneurial activities (even those within large firms). Long before others noticed that firms might benefit from inter-firm collaborative innovation, Walter not only saw the benefits but also some of the major problems that firms face as they engage in joint innovative activities.

Finally, I guess that from a Schumpeterian perspective on generating new ideas, one can say that Walter was a true innovator: Walter was not so much the inventor who generates completely new ideas, Walter's greater strength was in recognizing the relevance and potential impact of particular new ideas, of finding new combinations, and to search for new practical applications. In that sense, through his capability of finding new combinations, Walter Zegveld was a true Schumpeterian innovator and intrapreneur.

References

Ahuja, G. and Lampert, C.M. 2001. Entrepreneurship in the large corporation: A longitudinal study of how established firms create breakthrough inventions. *Strategic Management Journal*, 22, pp. 521–543.

Chesbrough, H.W. 2003. *Open innovation: the new imperative for creating and profiting from technology*. Harvard Business School Press, Boston (M.A).

Elster, J. 1983. *Explaining technical change*. Cambridge University Press, Cambridge (UK).

Freeman, C., Clark J. and Soete, L. 1982. *Unemployment and technical innovation: a study of long waves and economic development*. Greenwood Press, Westport (CT).

Johnson, W.M. 1972. *The Austrian mind: an intellectual and social history 1848-1938*. University of California Press, Berkeley (CA).

Love, J.H, Roper, S., and Vahter, P. 2014. Dynamic complementarities in innovation strategies. *Research Policy*, 43, pp. 1774-1784.

Nelson, R.R. and Winter, S.G. 1977. In search of a useful theory of innovation. *Research Policy*, 6, pp. 36-76.

Rothwell, R. and Zegveld, W. 1979. *Technical change and employment*. Frances Pinter, London (UK).

Rothwell, R. and Zegveld, W. 1981. *Industrial innovation and public policy: preparing for the 1980s and the 1990s*. Frances Pinter, London (UK).

Rothwell, R. and Zegveld, W. 1982. *Innovation and the small and medium sized firm*. Frances Pinter, London (UK).

Rothwell, R. and Zegveld, W. 1985. *Reindustrialization and technology*. Longman, London (UK).

Schumpeter, J.A. 1975 (1942). *Capitalism, socialism, and democracy*. Harper Torchbooks, New York (NY).

Zegveld, W. 1987. Technology and change in industrial societies: implications for public policy. *Technovation*, 5, pp. 215-227.

Walter Zegveld and Dutch innovation policy

Jeroen Heijs[16,17]

Over several decades Walter Zegveld had a huge influence on Dutch science and innovation policies. He played a very important role for the major investments in science and technology ìn the Netherlands from the 1990's onwards. In this period, he chaired the very influential Committee that advised the Dutch Government on these investments.

Walter Zegveld was a walking encyclopaedia of innovation policies. He knew everything and everybody in the fields of science and technology. Moreover, he had a very good sense for new developments. As one of the first, in the beginning of the eighties, he addressed Silicon Valley as a role model for the Netherlands already, when almost nobody understood its potential significance. He was always convincing in his persistent emphasis on the importance of technological innovation for the future of Dutch industry.

16 Jeroen Heijs (Ministry of economic Affairs) was Head of the Secretariat of the "Committee of Wise Men" in the period 2002-2012 and served as Walter Zegveld's right hand in this period.

17 Special thanks to Henk Gritter Msc for his contribution to this article.

Walter Zegveld and the investment programs for science and innovation

Because of his expertise and his extended network, Walter was asked to participate in quite a few advisory committees for Dutch Government. Between 1998 and 2008 he chaired the so called 'Committee of Wise Men' (or in Dutch: Commissie van Wijzen). This Committee advised the Dutch government on strategic science and innovation programs that were funded through the Economic Structure Enhancing Fund (FES), This fund was filled by the revenues of the natural gas extraction and the selling of shares in state-owned enterprises. It existed from 1995 until 2010.

FES was a very popular funding mechanism for science and innovation programs. The funding of innovation programs started with a budget of 200 million euros in 1998 for 12 programs. This was followed by a very large investment of 800 million euros in 37 large scale science and innovation program's in 2002/2003. After that there were several funding rounds of about 200 to 500 million euros.

The Committee of Wise Men had the task to review and select the proposals. And they did, in a very serious but also critical way. Many of the proposals therefore were rejected. Walter Zegveld used to say: "Well I'm not in here for the popularity poll". Some of the rejected proposers of course were very disappointed, and sometimes quite angry. Consequently, in turn they renamed the Committee of Wise Men into the "Committee of Wise Guys".

Walter Zegveld once calculated that during his presidency he approved about 2,3 billion euros on dozens of large to very large science and innovation programs. Some of these are still running.

For Walter Zegveld, the quality of an innovation program was defined by three questions:

- The first one concerns the added value. What is the real benefit of the program? And what societal problem does it solve, in the long term?

- The second question was whether the research question was demand driven. Is the proposal actually supported by the involvement of the private sector or is it merely academic interest?

- The third question dealt with the real evidence for this interest and involvement of the private sector. Is there hard and substantial financial commitment? "Put your money where your mouth is".

Walter Zegveld strongly underlined that innovation is not about research only. It's also about applying new findings. Walter pushed for innovations that could be of use, innovations that would not dissolve into thin air, but actually had a good chance of being marketed and ultimately have impact. Strong and substantial private commitments are good safeguards for this. At the end of his presidency we once calculated the effective total private contribution in the research programs that the Commission had approved. I remember Walter was very disappointed when we concluded that the figure was approximately 12,5 % of the total budget of the programs.

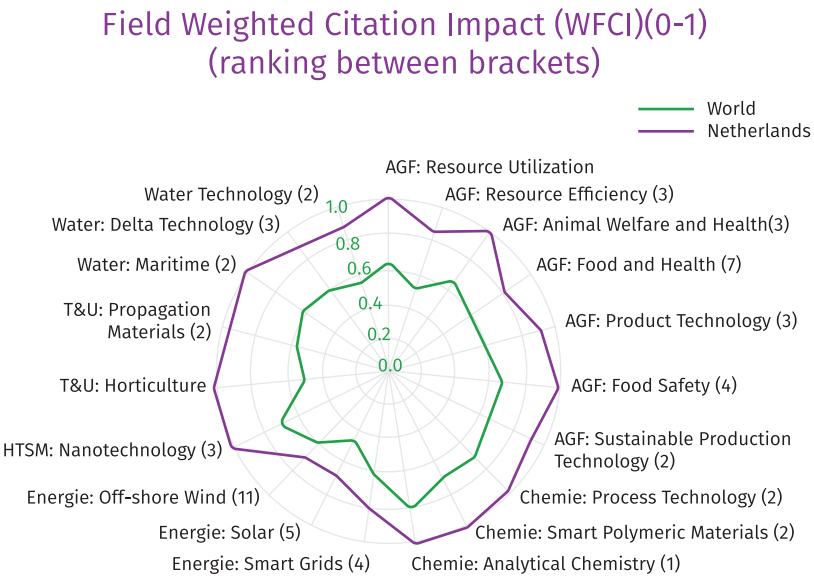
Changes in Dutch innovation policies

During the last decade, things certainly have changed a lot in Dutch innovation policies by the introduction of the TopSector policy. There are at least five big changes:

1. The Economic Structure Enhancing Fund (FES) was abolished in 2010. Natural gas production has been a substantial source of revenue for the Dutch State for more than 50 years. Between 1960 and 2013 the revenue totalled approximately €265 billion. During the period 1995-2010 in total 26 billion euro of natural gas revenues were allocated to the Economic Structure Enhancing Fund (FES) for investment projects to strengthen the economic structure. From this, 3,8 billion euro was invested in science and innovation programs. This Fund was abolished in 2010 and subsequently the major investments in science and innovation programs from this Fund stopped.

2. From 2011 onwards a new financing mechanism was created: the TKI-Allowance. Through this mechanism Dutch government invests a quarter (25%) for every private euro that is invested in public research agendas of the designated Topconsortia for knowledge and innovation (TKI). The TKI stimulate public-private partnerships in which entrepreneurs and scientists of the 9 Top Sectors explore new potential products and services. TKI–programs can have a strong scientific character or a more applied character. Products, processes and services that are developed bring about solutions for societal challenges such as traffic congestion or high health costs. Additionally, these innovations contribute to a higher productivity and economic prosperity. Annually about 100 million euros is invested by the government. The close cooperation between private companies and public research institutes results in very high-quality research, as is shown in the citation impact scores for the TKIs.

Fig 1: Citations Impact Scores TKI's

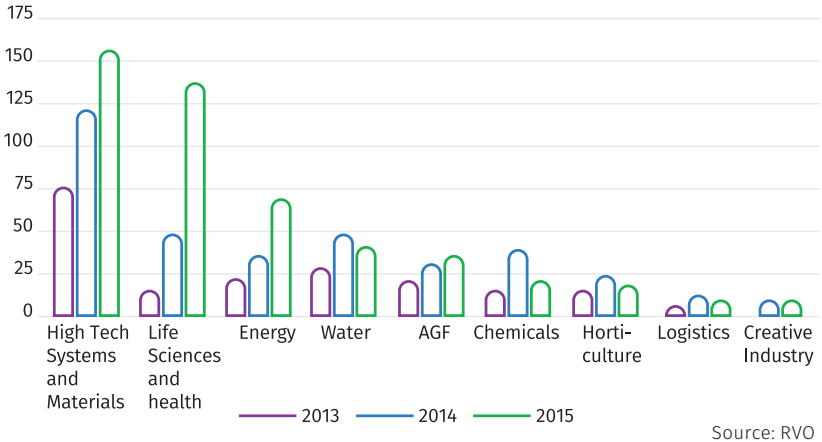


3. About 250 mln euros of the annual budgets of the big knowledge institutes (the TO2-institutes) and a substantial part (275 mln euro) of the budget of the national science board is programmed and coordinated in a demand oriented way. Additionally, the TO2-institutes (Deltares, DLO, ECN, NLR, MARIN, TNO) have intensified their collaboration by working on joint projects. Examples are big data analysis for smart farming and multi-material additive manufacturing. Moreover, they have continued their efforts to promote the involvement of Top Sectors and departments in the institutes' long-term knowledge-based basic research so that the knowledge developed effectively meets the needs of its users.

4. The key aim of the government is to get scientists and businesses to focus more on the economic and societal applicability of their research findings. Which is exactly what the Top Sectors are increasingly doing. The Netherlands has a National Science Agenda, which identifies broader questions for scientific research. Questions that relate to societal challenges – like the need to save energy and generate renewables – and that also contribute to economic growth. We call this approach 'Global challenges, Dutch solutions'.

5. And last but not least, as a result the private contribution to public research has increased substantially. There is a closer cooperation between public-sector researchers and businesses, especially in the Top Sectors. One consequence is that businesses have invested more in public research. The target for annual investment in public-private partnerships was 500 million euros in 2020. This was achieved already in 2013. Therefore, the target was raised to 800 million euros. In 2015 total investment in public research was over 1 billion euros, where businesses contribute almost 50% of the investment. In other words: the private sector invests 500 mln euros in public research.

Fig 2: Private contribution in Public private partnerships of Top Sectors



Source: RVO

Table 1: Dutch R&D expenditure in 2011-2014

	2011	2012	2013	2014
R&D expenditure as a % of GDP	1.90	1.94	1.96	2.00
- of which the private sector accounts for	1.08	1.10	1.09	1.12
- of which the public sector accounts for	0.83	0.84	0.87	0.88
R&D expenditure, in millions of euros	12,235	12,512	12,746	13,268
- of which the private sector accounts for	6,922	7,078	7,095	7,433
- of which the public sector accounts for	5,313	5,435	5,651	5,834

Source: Statistics Netherlands (CBS), Statline

What would Walter say?

Now we come to the most important question of this contribution: what would Walter say?

It is hard to speak on his behalf, but let's make a humble guess on what Walter Zegveld would think of the changes in Dutch innovation system. Therefore, let's go back to his three pervasive questions that were mentioned above:

First: is there added value?
I think we can be positive on that. The public-private research agendas have clear scientific *and* economic goals and address the big societal challenges as well.

Second: is it demand driven?
I think we can answer positively on that also. The private sector is well established in the driving seat, alongside with academia and applied research, to program the public-private research agendas.

Third: is there real evidence for the interest of private sector? In other words: Do they put their money where their mouth is?

I think Walter would be very excited about a 50% private support on the research programs, in comparison to the modest 12,5% in the FES programs. But he could ask a critical question on the total budget for innovation policies from government and private sector: is the 2% of our GDP that we invest on innovation sufficient for the big challenges we face?

References:

Heijs, Jeroen; Rik Timens, Janneke Timmermans, Rosemarie Wijnands (2008) *"De Commissie adviseert het kabinet derhalve ....." – Verzamelde adviezen van de Commissie van Wijzen onder het voorzitterschap van Prof. ing. W. Zegveld (1998-2008).* Den Haag, Senter-Novem.

Hessels, Laurens; Jasper Deuten (2013) *Coördinatie van publiek-privaat onderzoek. Van variëteit naar maatwerk.* Den Haag: Rathenau Instituut.

Jacobs, Dany (2009) *Creatief innovatiebeleid?* Amsterdam: Vossiuspers.

Meijerink, Rien; Peter Kwant, Mark van Twist (2010), *Evaluatie procedure Fonds Economische Structuurversterking Domein Kennis, Innovatie en Onderwijs.* Den Haag.

Velzing, Evert-Jan (2013) *Innovatiepolitiek. Een reconstructie van het innovatiebeleid van het ministerie van Economische Zaken van 1976 tot en met 2010.* Proefschrift Universiteit van Amsterdam.

Dual-use technologies

Christien Enzing[18]

It was late 1984 and I - as member of the Board of the Dutch Union for Scientific Workers (VWW) - was chairing the Conference on Technology Assessment that VWW had organised. Jos Leyten and Ruud Smits of the TNO Centre for Technology and Policy Studies (TNO-STB), at that time very active in the field of TA, were in the audience. They approached me and asked if I would be interested to work at TNO-STB. If I started to work there, it was as a sort of personal secretary of Walter Zegveld.

I was interested, very much. I quit my job as junior researcher at the Science and Society group of the University of Utrecht, left my PhD work for what it was (later - in 2009 - I got my PhD degree, yet) and started to work for Walter.

As Jos Leyten and Frits Prakke wrote in Walter's CV for this conference: "At that time – mid 80s - he was the tireless messenger of the new innovation policy in several governmental departments (such as the Ministry of Education, Culture and Sciences, and the Ministry of Economic Affairs) as well as in the Prime Minister's office and the main advisory council of the government".

After Walter's visits to the ministries, he regularly came back with new consultancy assignments. I did the preparatory work and Walter and I dis-

18 Between 1985 and 2009 Christien Enzing worked for TNO-STB and its successor organisations. She is now associate senior consultant at Technopolis Group in Amsterdam.

cussed the material that I had provided, conclusions were drawn and recommendations formulated, all written down in a report for the Minister. In the one and a half year that I worked for Walter, we prepared advises on:

- New issues in science and technology policy, under the title "Discontinuities in the process of knowledge generation, knowledge transfer and knowledge transformation"
- Facilitating of new R&D equipment for universities
- Education and Labour market: Consequences of the rapid rise of the level of knowledge and expertise for the labour market
- Higher Education by public and private organisations in Europe.

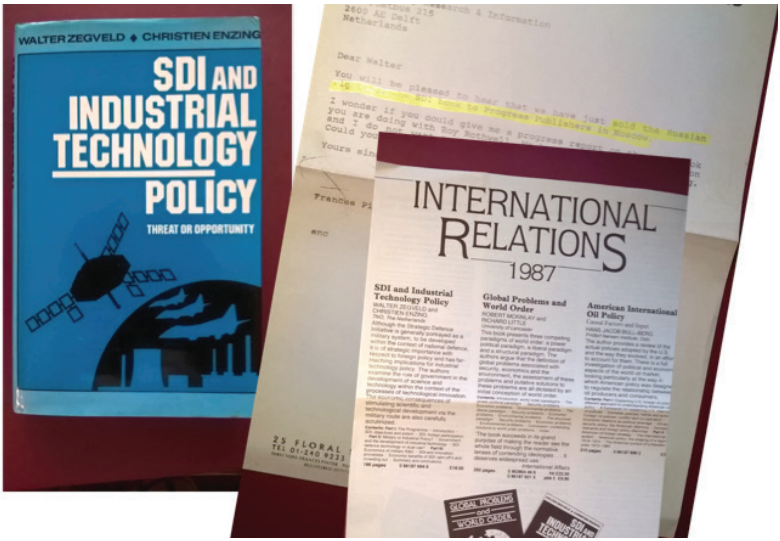
The strategic defence initiative

Most interesting and challenging was the report on the US Strategic Defense Initiative (SDI) that was first announced in March 1983 by President Reagan. The research and development programme of the SDI Organisation, was defined to explore key technologies which might enable the development of a missile defensive system intended to protect the United States from attacks by ballistic strategic nuclear weapons.

SDI was nicknamed as "Star Wars", after the popular film by George Lucas. Its first stage was planned to run for four years and started in 1986. It was succeeded by other programs, renamed and in the late 90's transformed into a program that had changed its scope from global to more regional coverage. Wikipedia says that the strategic defence system was never truly developed or deployed, though it created significant technological advances in computer systems, component miniaturisation, sensors and the missile systems paved the way for some of the anti-ballistic missile systems of today.

We wrote the report (it was for the Dutch Minister of Education, Science and Culture) and a meeting was organized where we presented and discussed our findings. In 1987, the English version of our report was published by Francis Pinter, who had published several books that Walter had written together with Roy Rothwell. We received many reactions on the book, it was reviewed in scientific journals and used in university lectures on technology and innovation policy. Francis Pinter sold the Russian rights of the book.

For me this was an interesting and challenging project. From a personal point of view, I preferred to stay far away from defence technologies as in practice, they are mostly operated as offense technologies. But most interesting was the question: How to relate a defence technology program, to the more general innovation theme? Why would a minister of Education, Culture and Science (at that time still with 'Innovation' in its portfolio) want an advice on SDI? We could only investigate SDI by not framing it as a defence research program, but as a dual use research program.



This was also the reason behind the Minister's request. Peter Tindemans - at that time our direct contact person at the ministry - explained later the political context within which their request to Walter should be understood. As many NATO allies, also the Netherlands had sent a fact-finding team to the USA to get a better idea of SDI and to discuss potential participation of Dutch companies, universities and research institutes. He joined this team and wrote the part of the report on the potential interest for civilian technology; he was rather negative on this aspect. Mid 1985 the French president Mitterrand launched EUREKA, a European and civilian alternative to the SDI research; it was a very political gesture. Within that context, the Minister of Education, Culture and Science was interested in a more thorough analysis of what SDI would mean for US industrial competitiveness and thus for potential European responses.

The hidden goal of SDI

SDI's huge investments - in its first four years, it had a budget of 30 billion dollars - were predominantly made in basic research at national laboratories, universities, and in industry. The SDI program and its successors have continued to be key sources of funding for research in the fields of high-energy physics, supercomputing/computation, advanced materials, and many other engineering disciplines.

The hypothesis that we tested was:

Given the dominant free-market philosophy in the US that does not allow for direct government interventions in the market through industrial technology policies

- Can a defence technology programs such as SDI be considered as a hidden trajectory to fund industry relevant research?

- Is the military route a more appreciated and appropriate way for such involvement in the US?

Our approach to SDI was motivated by the defence-economy debate in the US, acknowledging that military production was responsible for pulling the nation out of the Great Depression of the 1930s.

A sort of Keynesianism rescued the economy, a variant of Keynes in which the large demand-creating government intervention in economy was almost wholly military in origin. This position was further elaborated by Galbraith who stipulated that large complex organisations – including the military complex - were the defining characteristics of the US' economy. Others, such as Melnam, warned against the Pentagon's influence and dominance over the civilian economy and its control over R&D, capital, means of production, and technical personnel.

Tirman concludes that the 'spin-off' argument is key to understanding the defence-economy debate.

- If the defence budget is a drain on the public-sector budget without returning enough tangible benefits, then the conclusion is clear.

- But if the returns are not only security but steady advances in the technological frontier where also the civil sector can profit from, then Melnam's argument is less compelling.

In our SDI study, we explored this spin-off argument. We concluded that - although the R&D projects funded by the SDI Organisation are mainly generic by nature, and might generate civil applications - the exotic nature and the military context of the program and the extensive restrictions on technology transfer (with demanding restrictions on publication and participation of SDI-funded scientists in open scientific meetings) will reduce the possibility of commercial spin-off.

What would Walter say?

In 2016, the European Commission has announced that it is planning to increase the European defence research budget. On September 14, President Juncker stressed in his State of the Union Speech the need for a Europe that protects, empowers and defends.

Juncker states that the Europe's defence research budget should grow. In the new budget proposals for the period 2021-2027, this should amount to an annual budget of 500 million Euro.

Research should focus on for instance the development of a European Drone that can eliminate ground-based targets from high altitudes.

In a second phase, when the new weapon systems have been developed by European companies, budget should be made available (about 5 billion Euros, annually, based on contributions from individual member states) from which these weapon systems can be procured.

After Trump's election, it became clear that Europe should strengthen its contribution to the NATO, and this brought more fundament under Juncker's argument that Europe should work more closely together in defence R&D and procurement.

What would Walter say about this new initiative? He might conclude that Juncker's defence research program is – as we use the terminology of today – focused at higher Technology Readiness Levels than SDI. So, the proposed research is less basic, less fundamental and much more application oriented. This makes – at least in theory - the dual use less feasible, as the application is already integral part of the research.

For now, it seems to be a program that aims to strengthen the competitiveness of the European defence market, that suffers from fragmentation and insufficient industrial collaboration. However, with the shrinking national defence budgets (in the Netherlands, soldiers even sometimes practice with wooden guns) it remains to be seen how large the European market will be for these new weapons systems. Perhaps that with the current state of technology transfer from the research domain to the use domain, there might be some spin-off, more than what Walter would have expected.

Innovation for What and for Whom?

Nicholas A. Ashford, PhD., JD[19]

Background and history

First let me say what an honour it is to have been asked to participate (through the wonders of SKYPE) in the symposium organized to pay tribute to Walter Zegveld and to contribute this offering to the written commemoration of that gathering.

My connection to the Netherlands and to him go back a long way. As a graduate student in chemistry I spent two summers (1960 and 1961) in the Shell Research Laboratory in Amsterdam, directed by Jan van der Waals and did my best to learn some elementary Dutch, reinforced since by a year's sabbatical in 1998-1999 at Delft (in Technology Assessment) and the Erasmus Universiteit (in the Law Faculty). Although I completed my PhD in chemistry at the University of Chicago in 1965 and taught freshmen chemistry at the Illinois Institute of Technology while working on the US Space Program, four years later I found myself in the law and economics program at Chicago. Sputnik was on my mind and I had a vague idea that technology policy in the US needed to be rethought and taken much more seriously.

In 1972, I joined the new Center for Policy Alternatives at MIT headed by Herbert Hollomon, former Undersecretary of Commerce for Science and Technology, who was brought to MIT by its new President Jerome Wiesner, former science advisor to Presidents Kennedy and Johnson. These far-sighted men,

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impressed by what a concerted effort in science and technology could do for the military and the space effort, were convinced that promoting a civilian technology effort could do much for the welfare of society. *Limits to Growth* had just emerged from MIT's Jay Forrester and Dennis Meadow and environmental, labor, and economic challenges needed attention.

I succeeded Hollomon as Director of the Center and, interestingly enough, until the centre was rebaptized during the Reagan Administration as the Center for Technology, Policy, and Industrial Development under a new director, all of the research up to then was funded by the government, not by the private sector. This included the (now defunct) US Congress's Office of Technology Assessment; the National Science Foundation (NSF); the Departments of Commerce, Transportation, and Labor; the EPA; and the Consumer Products Safety Commission.

We persuaded the NFS that an investigation of the motivations, successes and failures of government support for civilian technology in five countries (France, Germany, the Netherlands, the UK, and Japan) and in five sectors might teach the US something. This MIT five-country study (Allen et al., 1978) was similar in scope to the six-country study being undertaken by Roy Rothwell at SPRU in Sussex. I directed the MIT study and we undertook to engage in the project the deep European thinkers in innovation including Chris Freeman (SPRU) and Walter Zegveld. One of MIT Tom Allen's graduate students from the Netherlands was Frits Prakke. This multi-national cadre of bright, motivated participants has contributed in various ways over the years to industrial and technology policy intended to benefit society.

Innovation is MIT's middle name and innovation has driven both academic and government policies on both sides to the Atlantic to be almost obsessed with its promotion, but sadly, not in the ways that motivated Walter

and his multi-national colleagues. Both academia and government have not only bought into the mantra "innovation is the engine of economic growth" but have translated that belief in asserting that promoting innovation in the private sector – or in partnership with universities - and having its benefits trickle-down to ordinary society, would be assured without careful government oversight and requirements for accountability. Environmental, employment, and economic welfare improvements were assumed to result, but increased inequality of wealth and income, reluctance to tackle global climate change seriously enough, the dismantling of environmental regulation, and the deskilling of the work force now loom as large challenges in developed countries – as does the essentially unregulated movement and ownership of global capital. And yet what we hear from both the private sector and government policy representatives is that we must do away with innovation and job-killing regulation, ignoring the numerous studies on both sides of the Atlantic that regulation can stimulate innovation [Ashford et al. (1979, 1985, 1983, 2002, 2011a, 2011b, 2015); Pelkmans and Renda (2014); and Jänicke, and Jacob (2004; 2005)] and yield important economic gains for the society. Forgotten from the findings of the MIT Five-country study was the observation that the only government policy positively correlated with increased economic performance was health, safety and environmental regulation [Allen et al (1978)]. Of course, there are winners and losers, but government seems increasingly willing to cater to the potential losers.

Today we hear of innovation deficits in the developed countries, without examining the diffusion deficits which prevent better technology – already developed – from entering the market because of excessive control of both the research and political agenda by the incumbents (Ashford and Renda 2016). Walter would certainly have something critical to say about the current trajectory of industrial society.

What have we learned about the innovation process that could be useful today?[20]

Generic Options for National Governments (in order of increasing intervention)

- Provide a suitable business and financial environment and legal infrastructure. (minimal role for government)

- Provide federal support for science and new product and technology development. ("big science" initiatives)

- Augment the ongoing processes – involving stakeholders in various networks -- in the innovation process (traditional industrial policy) See the first figure below.

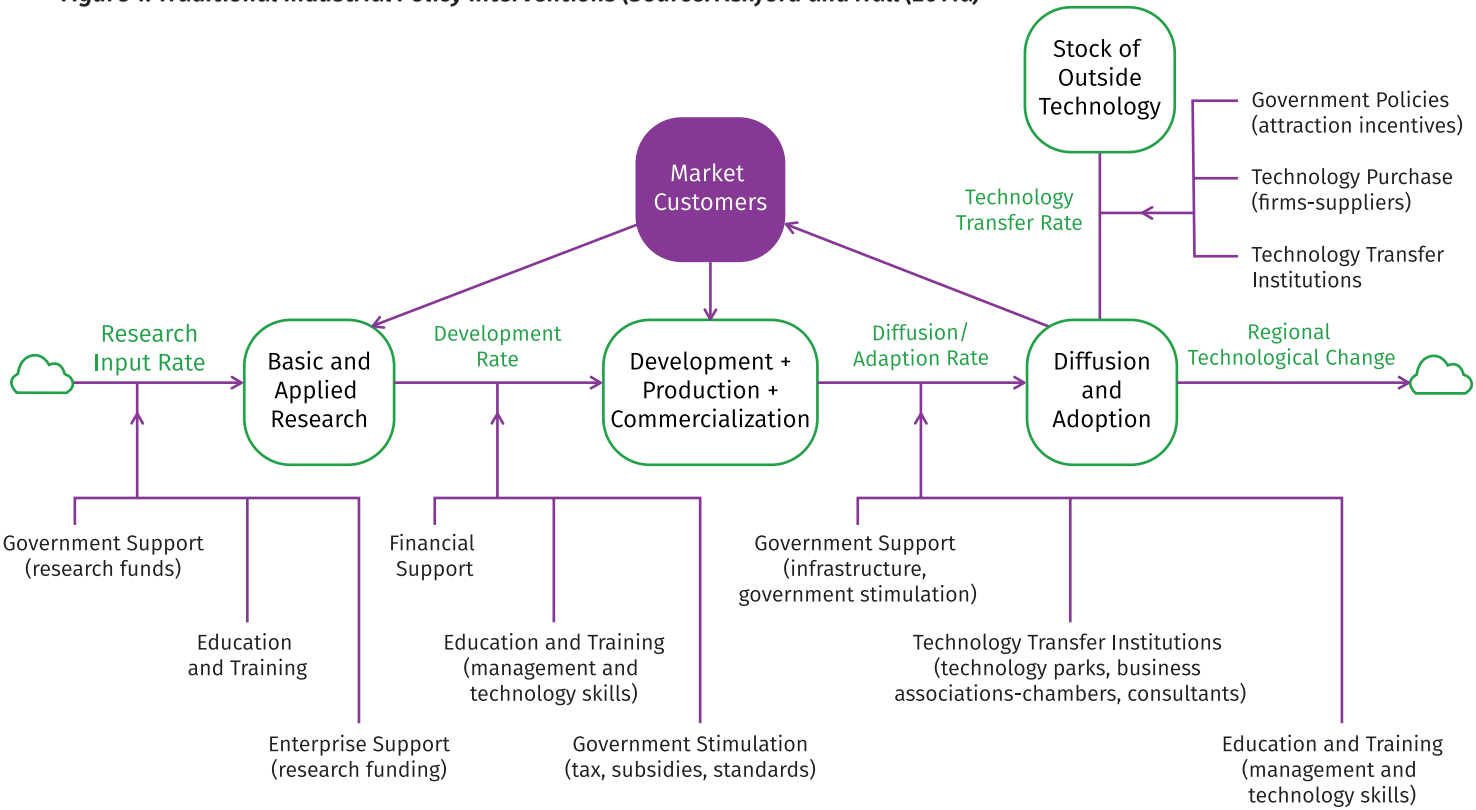
- *Actively manage/steer evolutionary change in industrial firms (co-evolutionary strategic niche development; transition management).*

- *Create mandatory targets for performance and operations that may be beyond the current capacity of incumbent firms and current networks in an integrated vision focusing on system changes. (maximum intervention)*

The role of the government in promoting innovation is presented in Figure 1, indicating all the traditional ways in which innovation might be stimulated (Ashford and Hall 2011a).

20 This discussion is taken from Ashford and Hall 2015

Figure 1: Traditional Industrial Policy Interventions (Source: Ashford and Hall (2011a)



The interventions depicted in the figure are of course familiar to those involved with traditional industrial policy that focuses on singular product or process changes. System innovations, discussed below, such as the transportation system or the agricultural system necessarily involve multiple economic actors interacting in larger venues and this model does not adequately represent the complexity involved in system transformations. Technology push innovations are pursued by profit-seeking firms and by countries seeking to enhance domestic and trade revenues (capital supplied by firms and subsidized through R&D innovation programs & cost-sharing through business tax deductions – and in the case of trade and aid, Export Credit Agencies, Sovereign Wealth Funds and Overseas Development Grants).

In contrast, there are often nascent or express market needs demanding to be satisfied. Market pull innovations can also be pioneered (Jänicke and Jacob 2005) by firms recognizing an unmet societal or market need and direct their innovative efforts towards that end. Often the demand is difficult to assess and can wane over time. An example is the need for a better chemotherapeutic approach to cancer, or increased concern for finding a cure for Alzheimer's Disease. Often, the R&D need is cutting-edge and financially risky. Government often supports the initial forays into research as exemplified by the development of computers, aircraft, and the Internet (Mazzucato 2014).

When it comes to stimulating innovation (and diffusion) of system transformations – or technologies that have remained unchanged for decades -- there seems little doubt that government setting of specific medium - to long-term mandatory targets, plus economic support, is indispensable for achieving transformations within a reasonable period of time (Ashford et al, 1985; Pelkmans and Renda 2014). Regulation and mandated targets essentially collectivize public demand or needs through the setting of standards and requirements. Costs are imposed on the private sector with cost-sharing achieved through business and R&D deductions. Sometimes

subsidies are provided. Governments need to understand the different forces giving rise to innovation and diffusion, and not succumb to traditional industrial policy if serious transformations – especially involving the displacement of incumbents or system changes involving many different economic actors – is what is needed. In the last decade, the concept of co-evolutionary innovation has been introduced by Dutch researchers injecting government and stakeholder guidance in the selection process entailing strategic niche management and transition management (Grin et al., 2010). This co-evolutionary process is advocated for system innovation, but its promoters admit the transformations can also take decades to achieve. A previous criticism of depending on these co-evolutionary processes to achieve systemic sustainable transformations can be found in Ashford and Hall (2015).

We certainly believe that system transformations are key to achieving system transformation involving technological, organizational, institutional, and societal innovations among a disparate collection of economic actors, but a much more directive role for government to meet the challenges is needed through an integrated approach utilizing regulations, targets, and appropriate economic signals. The government must take on the role of trustee for the needed transformations – and trustee of the technologies and firms of the future, often not yet represented at the negotiation table -- not of referee, teacher, or generator of consensus.

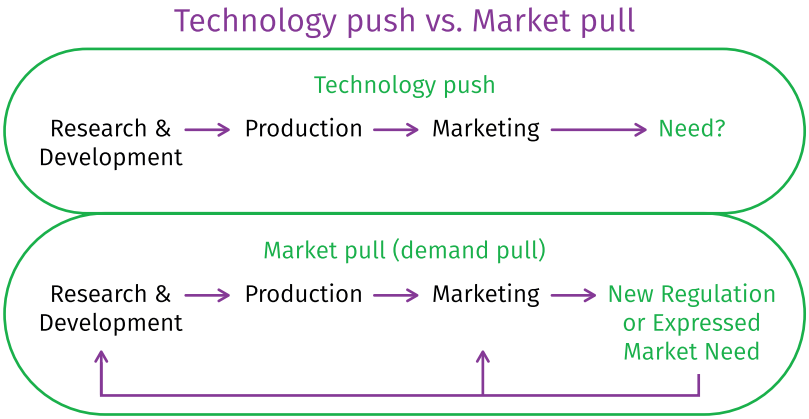
Finally, one of the bottlenecks in commercialization of useful technologies may come late in the innovation cycle. The innovation literature emphasizes the importance of *deployment* - the step in which a technology moves from bench-top or lab to actual commercial use in practice. Semantic preferences differ as to whether this is described as the last step in the innovation activity or the first step in diffusion. Semantics aside, what is important is that the R&D to accomplish this transition is not basic research, but truly *applied* research, a distinction glossed over in discussions of innovation policy. Barriers to deployment are often influenced

by incumbents whose technologies compete with the new technology and seek to delay or prevent its entry.

Other Policy Approaches for Stimulating Industrial Transformations Beyond Traditional Industrial Policy

- Strategic Niche/Transition Management (SNM/TM) [Geels 2004; Grin et al. (2010); Kemp (et al. 2007); Rotmans et al (2001s, 2001b, 2008)]
- Evolutionary/co-evolutionary approach addressing both technological and organizational changes/innovation – most likely to promote sustaining innovation.
- Integration of policies and strong intervention by government
- setting clear demanding targets (regulation) to encourage revolutionary change
- possible shift from products to product services
- encourage more comprehensive system changes
- Integrate, rather than merely coordinate polices

These alternative approaches are discussed below. They differ in the extent that demand pull and technology push predominates.



Source: Adapted from http://en.wikipedia.org/wiki/File:Technology-Push_Market-Pull.png

Strategic Niche Management (SNM) [Geels 2004; Grin et al. (2010); Kemp (et al. 2007); Rotmans et al (2001s, 2001b, 2008)]

- SNM emerges as the successor of ecological modernization and reflexive law

- SNM is the "creation and management of a niche for an innovation with the aim of promoting processes of co-evolution" – i.e., the evolution of a technology within a network

- *Approach*: A new product or process is used by real users to promote interactive learning and to build product constituencies

- SNM enables institutions and organizations to adjust the technological development and deployment process to stimulate the adoption and diffusion of a new product or process

- SNM leads to incremental system improvements and system innovations/regime transformations (*a large number of incremental innovations is alleged to eventually result in disruptive changes – this is highly questionable and confuses radical change with disruptive change)*

- The process is expected to take decades.

Government is Essential for Sustainable Development

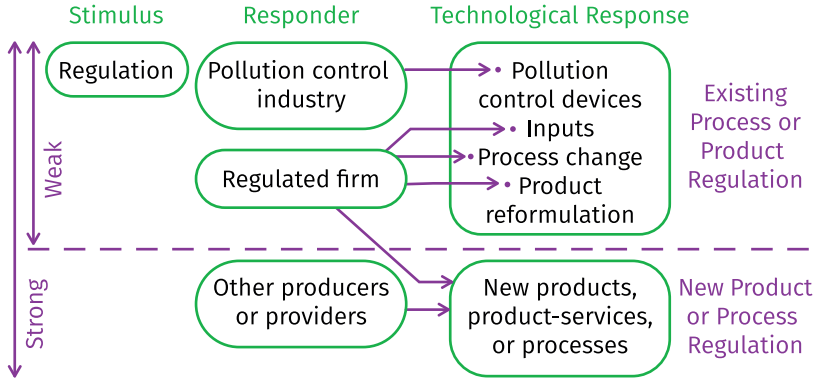
- As a supporter of basic education and skills acquisition

- As a provider of physical/legal infrastructure

- To invest in path-breaking science and technology development – for increased productiveness, environmental improvement, and job design

- As a facilitator or arbitrator of competing interests to ensure a fair process
- *As a trustee of worker and citizen interests* to ensure a fair outcome in commerce (e.g., through banking, labour protection, and trade regulation)
- *As a trustee of new technologies & dynamic change, societal innovation.*
- As a force to integrate, not just coordinate different policies
- *As the implementer of Regulation (finance, anti-trust, safety, health, environment, labor markets, and trade). This is essential.*

A Model for 'Weak'(Porter) and 'Strong'(MIT) Forms of the Regulation-induced Hypothesis



Fundamental questions in approaching sustainable transformations

Most analysts would ask here three questions:

- What are the causes of unsustainable industrial systems?
- What are the visions for a sustainable future? (open up the 'design space' to achieve multiple goals)
- What are the carrots and sticks that need to be fashioned to achieve that future?

But an important additional question, deserving equal attention is:

- What or who is standing in the way of achieving that future?

Solutions will require:

- Opening up the "problem space" for envisioning, designing, and implementing more sustainable policies – to include concerns for economic welfare, energy, environment and public health, and employment & earning capacity.
- Opening of the "participatory and political space" for ensuring that all relevant voices have influence in the processes of change – not just those with wealth and political power.
- A stronger, but not necessarily bigger, government. One that enforces law and develops an integrated vision

Key Questions

- How likely is it that the needed sustainability changes evolve without government intervention and over what time period?

- If the government greases the innovation system – i.e., improves the climate for innovation – through traditional industrial policy by making it more efficient, e.g., increasing rewards to innovation through better patent or IP policy or tax treatment of investment etc., will this give rise to more and faster development of sustainable innovation, or just generate more profits?

- If we move to a more innovation-interventionist and targeted approach with incentives given for more sustainable versus unsustainable innovations in specific problem areas, e.g., in energy, what is the likelihood that incumbents versus new entrants will lead the pack?

- Do we need stringent/strong regulatory requirements/sticks instead, or as well? Is an incentive-based strategy necessary? Sufficient?

- Who is most likely to respond to stringent regulatory fiats, incumbents or new entrants?

- Are existing systems likely to change easily?

- Are the answers different for different sectors/problems – e.g., toxic chemicals versus energy sources/efficiency?

- Are the answers different in different nations?

Perhaps my remarks raise more questions than they answer, but learning requires that we begin by asking the right questions. Walter would certainly have agreed.

Summary of the importance of government

Government has an important role to play in creating winning forces and visions for sustainable transformations (Ashford, 2000, 2002c, 2005). Depending on the type of transformation required, the roles of government should encompass the following (Ashford 2002b, pp. 18-19):

- The direct support of R&D and incentives for innovation through appropriate tax treatment of investment;
- the creation and dissemination of knowledge through experimentation and demonstration projects;
- the creation of markets through government purchasing;
- the removal of perverse incentives of regulations in some instances and the deliberate design and use of regulation to stimulate change in others;
- the training of owners, workers, and entrepreneurs, and educating consumers;" and
- the direct creation of meaningful, rewarding, and satisfying jobs.

It should be clear how these roles relate to the ideas embedded in SNM and TM approaches, but we envision a much stronger role for government in stimulating technological innovation. Government should go beyond simply creating a favorable investment climate. "Without deliberate design, significant changes – even system changes – are unlikely to improve competitiveness, environment, and employment at the same time" (Ashford and Hall 2015). As discussed in the next section, *stringent regulation* (focusing on environmental, health, and safety issues) is essential to stimulate significant technological changes, and such regulation may in fact

be necessary to create niches that facilitate the entry of new firms and organizations into a new market.

Others who support the view that stringent (or "properly conceived") regulation is necessary for environmental innovation include Foxon et al. (2004), Huber (2004b), and Jänicke and Jacob (2004, 2005). For instance, Huber (2004a, p. 447) comments that "strict environmental performance standards … [remain] by far the most effective controls instrument for environment and innovation alike (which is not astonishing given the fact that environmental standards are, or immediately translate into, technical standards)." Perhaps what is astonishing is the largely absent mention of government regulation in the SNM and TM literature. See Pelkmans and Renda (2014) for a recent review of the stimulating effects of regulation on innovation.

Ashford et al. (2002) argue that an *evolutionary* (or incremental) pathway is insufficient to achieve factor ten or greater improvement in a system's performance. Further, because changes in sociotechnical systems (such as the transportation or energy system) are difficult, the "creative use of government intervention is a more promising strategic approach for achieving sustainable industrial transformations than the reliance on the more neo-liberal policies relying on firms' more short-term economic self-interest" (ibid., p. 10). Hence relying on Christensen's (1997) approach to radical disrupting innovation is seen as being unlikely to result in "system" transitions toward sustainable development; however, disrupting forms of technological change are likely to continue.

In addition, Ashford et al. (2002) state that governments should work with stakeholders to define future targets – while ensuring that their agendas are not captured by incumbent firms – and then use their position as trustee to "represent the future generations and the future technologies to 'backcast' what specific policies are necessary to produce the required technical, organizational, and social transformations" (ibid., p. 10).

It is likely that an evolutionary pathway is insufficient to achieve factor ten or greater improvements in eco- and energy efficiency and reductions in

the production and use of, and exposure to, toxic substances. Such improvements require more systemic, multidimensional, and disruptive changes. We have already asserted that the capacity to change can be the limiting factor, and that this is often a crucial missing factor in optimistic scenarios.

Successful management of disruptive product innovation requires initiatives and input from outsiders to produce the expansion of the design space that limits the dominant technology firms. Especially in sectors with an important public or collective involvement, like transportation, construction, and agriculture, this means that intelligent government policies are required to bring about necessary change.

Rigid industries whose processes have remained stagnant also face considerable difficulties in becoming significantly more sustainable. Shifts from products to product-services rely on changes in the use, location, and ownership of products in which mature product manufacturers may participate, but this requires significant changes involving both managerial and social (customer) innovations. Changes in sociotechnical systems, such as transportation or agriculture, are even more difficult. Thus, as Ashford et al. (2002) argue, the creative use of government intervention may be a more promising approach to realizing industrial transformations than relying on shorter-term economic interests.

This is not to say that enhanced analytic and technical capabilities on the part of firms and cooperative efforts and improved communication with suppliers, customers, workers, other industries, and environmental/consumer/community groups are not valuable adjuncts in the transformation process. But in most cases, these means and strategies are unlikely to be sufficient by themselves for significant transformations, and they will not work without clear mandated targets to enhance the triple goals of competitiveness, environmental quality, and enhancement of employment/labor concerns.

Government has a significant role to play, but the government cannot simply serve as a referee or arbiter of existing competing interests, be-

cause neither future generations nor future technologies are adequately represented by the existing stakeholders. And new stakeholders are only marginally likely to be brought into development by incumbents, notwithstanding the wishful thinking of SNM and TM advocates.

Government should work with stakeholders to define far-future targets, but without allowing the incumbents to capture the agenda. It has to go beyond its historical focus on coordinating public- and private-sector policies. It must be multidimensional and directly address the present fragmentation of governmental functions. This means that the various policies must be mutually reinforcing and the targets must be clear.

References

Allen, Thomas J., James M. Utterback, Marvin A. Sirbu, Nicholas A. Ashford and J. Herbert Hollomon, *Research Policy*, Volume 7, Number 2, April 1978, pp. 124-149.

Ashford, N.A.

---. 2000. An Innovation-Based Strategy for a Sustainable Environment. In Hemmelskamp, J.; Rennings, K. and Leone, F. (Eds), *Innovation-Oriented Environmental Regulation: Theoretical Approach and Empirical Analysis,* pp. 67-107. New York: Physica-Verlag Heidelberg.

---. 2002a. Government and Environmental Innovation in Europe and North America. *American Behavioral Scientist* 45(9): 1417-1434.

---. 2002b. An Innovation-Based Strategy for a Sustainable Environment. In Hemmelskamp, J.; Rennings, K.; Verlag, F.L.S. and Heidelberg (Eds), *Innovation-Oriented Environmental Regulation: Theoretical Approach and Empirical Analysis,* pp. 67-107. New York.

---. 2002c. Technology-Focused Regulatory Approaches for Encouraging Sustainable Industrial Transformations: Beyond green, beyond the dinosaurs, and beyond evolutionary theory. Paper read at 3rd Blueprint Workshop on Instruments for Integrating Environmental and Innovation Policy, 26-27 September, 2002, at Brussels.

---. 2005. Government and Environmental Innovation in Europe and North America.

In Weber, M. and Hemmelskamp, J. (Eds), *Towards Environmental Innovation Systems,* pp. 159-174. Heidelberg: Springer.

Ashford, N.A.; Ayers, C. and Stone, R.F. 1985. Using Regulation to Change the Market for Innovation. *Harvard Environmental Law Review* 9(2): 419-466.

Ashford, N.A.; Hafkamp, W.; Prakke, F. and Vergragt, P. 2002. Pathways to Sustainable Industrial Transformations: Cooptimising Competitiveness, Employment, and Environment. Cambridge: Ashford Associates.

Ashford, N.A. and Hall, R.P. 2011a. The Importance of Regulation-Induced Innovation for Sustainable Development. *Sustainability* 3(1): 270-292.

---. 2011b. *Technology, Globalization, and Sustainable Development: Transforming the Industrial State*. New Haven: Yale University Press.

Ashford, N. A. and R. P. Hall (2015). "Making Serious Inroads into Achieving Sustainable Development: Is Strategic Niche Management/Transition Management Sufficient to Transform the Industrial State?" Conference: 6th International Sustainability Transitions (IST) Conference. Sustainability Transitions and Wider Transformative Change Historical Roots and Future Pathways, At Brighton, University of Sussex Campus (Falmer), UK August 2015. Available at: https://www.researchgate.net/publication/280839263_Making_Serious_Inroads_into_Achieving_Sustainable_Development_Is_Strategic_Niche_ManagementTransition_Management_Sufficient_to_Transform_the_Industrial_State

Ashford, N.A. and Heaton, G.R. 1983. Regulation and Technological Innovation in the Chemical Industry. *Law and Contemporary Problems* 46(3): 109-157.

Ashford, N.A.; Heaton, G.R. and Priest, W.C. 1979. Environmental, Health and Safety Regulations and Technological Innovation. In Hill, C.T. and Utterback, J.M. (Eds), *Technological Innovation for a Dynamic Economy,* pp. 161-221. New York: Pergamon Press, Inc.

Ashford, N, and A. Renda (2016). "Aligning Policies for Low-carbon System Innovation in Europe" Center for European Policy Studies and i24C, Brussels. Available at https://www.ceps.eu/publications/aligning-policies-low-carbon-systemic-innovation-europe

Foxon, T.; Makuch, Z.; Mata, M. and Pearson, P. 2004. Innovation Systems and Policy-Making Processes for the Transition to Sustainability. In Jacob, K.; Binder, M. and Wieczorek, A. (Eds), *Governance for Industrial Transformation. Proceedings of the 2003 Berlin Conference on the Human Dimensions of Global Environmental Change,* pp. 96 - 112. Berlin: Environmental Policy Research Centre.

Geels, F.W. 2004. Understanding system innovations: a critical literature review and a concept synthesis. In Elzen, B.; Geels, F.W. and Green, K. (Eds), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy,* pp. 19-47. Cheltenham: Edward Elgar.

Grin, J.; Rotmans, J. and Schot, J. 2010. *Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*. New York: Routledge.

Huber, J. 2004a. Environmental Policy Shift Through Technological Innovation. In Jacob, K.; Binder, M. and Wieczorek, A. (Eds), *Governance for Industrial Transformation. Proceedings of the 2003 Berlin Conference on the Human Dimensions of Global Environmental Change,* pp. 438 - 447. Berlin: Environmental Policy Research Centre.

---. 2004b. *New Technologies and Environmental Innovation*. Cheltenham: Edward Elgar.

Jänicke, M. and Jacob, K. 2004. Lead Markets for Environmental Innovations: A New Role for the Nation State. *Global Environmental Politics* 4(1): 29-46.

---. 2005. Ecological Modernisation and the Creation of Lead Markets. In Weber, M. and Hemmelskamp, J. (Eds), *Towards Environmental Innovation Systems,* pp. 175-193. Heidelberg: Springer.

Kemp, R.; Loorbach, D. and Rotmans, J. 2007. Transition management as a model for managing processes of co-evolution towards sustainable development. *The International Journal of Sustainable Development and World Ecology* 14: 1-15.

Mazzucato, M. (2014) *The US Entrepreneurial State: Debunking Public vs. Private Sector Myths.* New York and London: Anthem Press.

Pelkmans, J. and Renda, A. 2014. Does EU regulation hinder or stimulate innovation? : Special Report, the Centre for European Policy Studies, No. 96, November 2014. Available from http://www.ceps.eu.

Rotmans, J. and Kemp, R. 2008. Detour ahead: a response to Shove and Walker about the perilous road of transition management. *Environment and Planning A* 40: 1006-1011.

Rotmans, J.; Kemp, R. and van Asselt, M. 2001a. More Evolution than Revolution: Transition Management in Public Policy. *Foresight* 3(1): 015-031.

Rotmans, J.; Kemp, R.; van Asselt, M.; Geels, F.; Verbong, G. and Molendijk, K. 2001b. Transitions & Transition Management. The case for a low emission energy supply. In *ICIS working paper: I01-E001. Maastricht.*

Service Innovation Policy – a small history about an emancipation process in innovation policy[21] [22]

Pim den Hertog[23]

Introduction

The development towards a service-driven economy is a process that has been under way for some decades now. It is increasingly acknowledged that in advanced economies most room for productivity growth stems from services and service innovation. In both our private and professional

21 Walter Zegveld created an open-minded and critical research community at TNO Policy Research where I could pick up and develop the theme of service innovation together with fellow researchers and guided by Jos Leyten. Either Walter or Jos handed me an early version of the 1996 OECD STI working paper by Alison Young on measuring R&D in the Services, which triggered my continuing research interest in services R&D/innovation.

22 This chapter draws heavily on Hertog, P. den (2010) and was enriched and detailed by an overview that I contributed to the OECD on service innovation policies (see Janssen et al, 2012) and in two ongoing research assignments. One is a project for the Dutch Ministry of Economic Affairs aimed at furthering non-technological innovation in manufacturing industries through two policy experiments. The second is a study launched in spring 2017 on the potential of servitisation and other forms of product-service provision for EU SMEs as part of the EASME/COSME programme to which Dialogic together with Technopolis and Cambridge Service Alliance will contribute.

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lives new (combinations of) service concepts and experiences, new type of service organisations and occupations and associated – mostly information and communication technology (ICT)- based – service technologies are ubiquitous. Developing and exploiting these innovative services requires technological as well as non- technological innovation, knowledge and capabilities.

The concomitance between the role of services in modern economies and the role of innovation in economic growth has increased the interest in service innovation from different angles, from academic research to statistical developments (such as the slow process of adapting the Community Innovation Survey), from new theories and typologies to a wider management and specific business plans for services innovation, from the inclusion of services in existing research and development (R&D) programmes to the development of new policy interventions. An increasing number of firms are managing service innovation more explicitly. In some countries innovation policy- makers have developed new, more services-innovation-friendly R&D and innovation policy frameworks, sometimes even service innovation schemes (den Hertog, 2010; Janssen et al, 2012) and more recently even service inclusive approaches towards innovation where the distinction between service innovation and goods-based technological innovation is discarded completely (see for example Janssen & den Hertog, 2016).

We view the way service innovation is looked upon and gradually integrated in innovation policy as a typical example of an emancipation process. At first it was difficult to convince academics, statisticians, innovation managers and policy makers alike that service innovation not only matters but has some typical characteristics which sets it apart from goods-based (technological) innovation. Subsequently mainly service innovation scholars were making a plea to see service innovation as a completely different species of innovation. More recently more multi-dimensional and systemic approaches towards service innovation have developed where

technological and non-technological dimensions of innovation are seen as intrinsically related in complex product service systems.

In the remainder of this chapter I first introduce how I define service innovation and describe in a stylized way its key characteristics (section 2). I subsequently describe three approaches to services R&D and innovation (section 3) before presenting various policy options for furthering service innovation (section 4). I conclude by pointing at the stage and direction in which the emancipation process described is heading.

Defining service innovation and why it matters[24]

Service R&D and innovation refers to new or significantly improved service concepts that create additional value for firms and their customers (also through co-creation). A service innovation is a new service experience or solution in the form of a new service concept, new customer interaction, new value system/business partners, new revenue model, and new organizational or technological service delivery system (den Hertog, 2010, p. 19). Such new dimensions or in combination, often lead to the customer being involved with further new service experiences or solutions. These require new technological or organizational capabilities on the part of the service provider to enable their introduction and distribution in the market. Service innovations can have technological components and do not necessarily rely on R&D-based strategies; but they do have the potential to significantly impact a wide range of firm activities, especially relationships with customers, delivery channels, and the development of new combinations of products and services.

The impact of services on the entire economy is substantial. Service R&D and innovation affects growth through three key mechanisms: a) the service sector accounts for 70% of GDP in most OECD countries; b) business services, especially knowledge-intensive services, are used as intermedi-

24 This section is largely based on Janssen, den Hertog & Kaashoek, 2012, pp 5-8.

ate inputs in production; and c) manufacturing firms increase their efforts to provide services in addition to their traditional business. It is important to emphasize that service innovation not only drives and affects the 'classic' service sectors (see NACE classifications), but also manufacturing companies innovate and use service contracts for machinery, consultancy activities, and leasing constructions to increase their turnover. In addition, business services – like consulting firms – can drive innovation with their analyses and advice. Attempts to increase the productivity of services R&D and innovation have been problematic for governments in many OECD countries facing slow economic growth. However other services have expanded, largely fueled by globalization and increasing use of ICT to enable more standardized services such as in health, education, and government. Innovative business services are part and parcel of today's global value systems and are increasingly sourced globally (see e.g. OECD (2012a) and (2012b)).

However, for a long time, the majority of innovation and management scholars, statisticians, policy-makers as well as the wider audience still associate innovation with technological innovation in a manufacturing setting. In their eyes, innovation is mainly the result of a concentrated R&D effort and the innovation process is seen to be linear.[25] Innovation management textbooks mostly talk about managing technological innovation. Likewise, technological definitions of innovation still dominate innovation surveys, and we are only on the brink of using more sophisticated methods to measure innovation in services and the wider scope of non-technical innovation. Similarly, over the years, policy-makers have learned to design and implement tools and programs aimed at furthering R&D and innovation in manufacturing industries and networks, but are struggling with, and seem hesitant to support innovation in services. This narrow-minded

25 This observation may be true for some firm managers, although many in service-dominant firms are already highly involved in service innovation processes.

approach does not sufficiently appreciate the characteristic features of service innovation which in my view needs to be integrated better in policy approaches to (furthering) innovation and growth.

In my view service innovations are multi-dimensional, involving numerous organizational alongside technological aspects.[26] Service innovation processes are non-linear and essentially 'distributed.' This means that the innovation of a service does not usually come from a concentrated and formalized R&D effort (the goods-based logic of innovation). On the contrary, it is more frequently the result of a fuzzy, distributed R&D and innovation process, (the service-based logic) involving many disciplines, departments including strategy, business development, marketing and service operations, and also clients.

Earlier five key characteristics of service innovation have been identified (van der Aa, 2000 and den Hertog et al., 2010):

1. Service innovation is a shared process. New concepts and related business processes are usually developed in a shared and interactive process between a service provider and its customers. In that sense, we can even label this as co-production or co-innovation. Many service innovations involve a change in the division of labor (and thus tasks and responsibilities) between service provider and customer. Examples are introducing self-service concepts like electronic banking, online check-in, or integrating additional services into existing products or offers such as all-inclusive holidays or document management as a service. The changes in customer-interaction and accompanying distribution mechanisms have had a major impact on many service innovations.

26 Earlier this was referred to as the soft side of innovation as opposed to the hard, technological side (den Hertog et al., 1997).

2. Service innovation has a conceptual and intangible nature. In most cases, service innovation does not result in a tangible product but involves value propositions which are hard to asses beforehand by potential customers. A new way to handle insurance claims, a new type of pool management in staffing services or new store concepts all have in common that they are highly conceptual. Thus communication and branding of new service concepts have become crucial.

3. Service innovation has a combinatory or architectural nature. Service innovations often take new combinations (Schumpeter's concept) of existing service concepts and apply them in a new context. Examples are triple-play provisioning of telecommunication services, bundled maintenance or facility services or self-service in health care (e.g. home dialysis).

4. Service innovation is demanding in terms of replication and scaling. Compared to goods-based innovations, service innovations are not easy to reproduce or replicate on a large scale. Mainly due to the human and cultural aspect, it is difficult to roll out a new service concept in numerous locations uniformly. For example, implementing a new franchise restaurant or store concept will differ from country to country. One particular aspect is the fit between an existing service delivery system and the newly introduced service. A new channel (e.g. a mobile payment functionality) imposes requirements on the organization and integration with other channels (multi-channel). A newly introduced service concept that cannot be distributed on a wide scale because of a failing service delivery system, cannot be called a (successful) service innovation.

5. Service innovation mostly originates from a distributed innovation effort. Service Innovations do not usually occur in a traditional dedicated R&D department or in a laboratory setting. On the contrary, most service innovation activities have a distributed character and are tested in real-scale and real-life environments and are usually the result of an elusive, fuzzy and often wide-spread quest. New services can be initiated by marketing, business development, ICT or operations departments and for

this reason, Sundbo & Gallouj (2000) have stated that service innovation systems have been labeled as loosely-coupled systems.

In the next section it will be illustrated how the emancipation process of service innovation has unfolded over the years.

The emancipation process at work: three perspectives on service R&D and innovation[27]

Quite a number of innovation scholars, statisticians, policy analysts and policy-makers have analyzed, measured, reported and discussed services R&D and innovation. This has not yet resulted in a coherent vision as to how to conceptualize, categorize, measure and facilitate services R&D and innovation. Innovation policy- makers seem to be increasingly aware of the key role service R&D and innovation play in driving economic growth. Some of them even recognize that there is a mismatch between the sheer size and economic role played by services and service innovations, and the sort of policy initiatives taken to further services R&D and innovation. However, in practice and with a few exceptions (Finland, Germany, Denmark, the European Commission), only a few countries have managed to define a policy framework for furthering service innovation and to design concrete programmes and schemes aimed at furthering service R&D and innovation. In my view this is to an important degree due to principally opposing views on the role of services R&D and innovation in innovation systems and the best way – if any – to facilitate these. Earlier, the many ideas and views on service R&D and innovation have been reduced to basically three approaches (Gallouj, 1994; Boden and Miles, 2000; Coombs and Miles, 2000).[28] These approaches – leaving out the approach of complete

27 The basis of this section is den Hertog (2010).

28 Extensions of these approaches have been done by Drejer (2002), Nahlinder (2002), den Hertog et al. (2006), Rubalcaba (2006), den Hertog et al. (2008) and Janssen (2015).

ignorance, as I presume this approach is no longer seriously supported[29] – are summarized in a nutshell in figure 1 below and discussed briefly below.

Assimilation approach

The assimilation approach mainly starts from the idea that R&D and innovation is still about technological R&D and technological innovation , that some services industries may play a role here, and that existing policies mostly need to be made somewhat more accessible for those service firms that perform technological R&D and innovation as there are no theoretical reasons justifying the exclusion of services. The central idea is that services and innovation in services can be analyzed and supported using or adapting the concepts and tools developed for manufacturing and innovation in manufacturing (Tether, 2005). In policy terms this means unavoidable biases for technological support as most services innovation is less technology- driven (Howells and Tether, 2004), even if there are indeed indications that technological R&D and innovation in service firms are under- reported (Miles, 2005; den Hertog et al., 2006). Most EU and national innovation policies can be characterised as belonging to the assimilation approach: services are ignored or are considered together with manufacturing under generic innovation policies. The horizontality is more theoretical than real since the bias towards technological R&D and innovation is more useful to goods industries than to service activities.

29 However, the 'productive- sectors (i.e. goods industries)- are- what- really-matters-approach' still pops up every now and then. Typical arguments used are, e.g., goods oriented R&D is led by the most advanced countries; intangibility of service innovation results prevents their evaluation; results of service innovation can hardly be appropriated; support for innovation could distort competition in the service sector, etcetera (based on Rubalcaba, 2007).

Demarcation approach

The demarcation approach is quite popular among services innovation researchers. They pointed at and reported on the peculiarities of services, the predominance of types of innovation other than pure technological innovation, and the different innovation processes or innovation styles of services R&D and innovation. As services R&D and innovation are conceptualised as rather different from the 'regular and well- known' technological R&D and innovation, a plea is made for new ways of measuring it and developing specific policy initiatives suited to services R&D and innovation. This would mean a development towards more specific or vertical R&D and innovation policies. There are also some views in favour of a specific focus on services. Heterogeneity of individual (service) industries and the fact that not all services are similar in structure, innovation behaviour and barriers to innovation encountered, would lead to the need for specific measures in particular markets. It is for example, not so easy to argue that a horizontal policy – beyond supporting business R&D – is enough to fulfil the interests of such uneven sectors as telecommunications, tourism, retailing or professional services. At the same time it can be argued that a demarcation approach would require a quite detailed understanding of individual industries by policy-makers. Further, the increased intertwining of services and manufacturing industries, the rise of service innovations deriving from manufacturing industries, and the fact that most innovations in both manufacturing and services are about combinations of technology and new services concepts and about how these are translated into sound business propositions, makes the demarcation approach a form of overshoot which in the end might not be that productive. Examples of typical demarcation-type service innovation policies are specific innovation programmes for health services or the promotion of innovation in the tourism sector.

Systemic approach

The synthesis or systemic approach refers to a more integrated view of the service economy and is based on the idea that technology and non-technological innovation, manufacturing and services innovation typically support and need each other. Most innovative firms realize that they also have to differentiate themselves from the competition by adding extra service functionality to both manufactured goods and services. It has even been suggested that the differences within industry and within services are in many cases more marked than between the two main categories (see Preissl, 2000; Gallouj & Weinstein, 1997; Sirilli & Evangelista, 1998). It further acknowledges the decisive role that intangible elements play in innovation and growth, and hence their relevance as objects of innovation policy-making. Seen from a systemic or evolutionary innovation perspective, a two-way approach is in my view relevant. Firstly, is the established innovation system (especially in terms of the wider institutional setup, built in incentives) designed and modeled well enough towards facilitating services R&D and innovation? Service innovation is understood as a horizontal dimension or intrinsic quality of an innovation system, and the lack of service innovation, as a failure of the system. Secondly, do the sets of firms dealing with or playing a role in service innovations contribute well enough to the overall quality of the NIS? Service innovation capability is a system characteristic that may help in improving the overall functioning of an innovation system. The systemic approach in this context points to the need to improve the relationships between 'goods' companies and 'service companies'.[30]

30 Especially, the role of knowledge-intensive (business) services (KIBS) is key here as these may provide necessary intermediate input to improve the competitive and innovative capacity of any manufacturing or service company (see Rubalcaba, 1999; Wood, 2001), are well linked to new technologies and especially their consolidation as part of the innovation system (see Antonelli, 1999; Miles, 1999; Boden and Miles, 2000; Metcalfe and Miles, 2000; Muller, 2001; Zenker, 2001; Hipp and Grupp, 2005).

Given existing evidence innovative services (in both manufacturing and services) can be considered to improve the dynamics of the overall innovation system or sectoral innovation systems (Miles et al., 1995; den Hertog, 2000; OECD, 2006; Rubalcaba and Kox, 2007). Especially business-related services – and probably most importantly knowledge intensive business services (KIBS) – can play multiple roles in making innovation systems more dynamic and better-performing. Increasingly KIBS are seen as being part and parcel of an effective entrepreneurial or innovation climate, and as a basic element necessary for developing wide and deep clusters and networks. In almost all competitive clusters and networks you will find highly specialized service firms that help other firms to become more innovative and competitive. Therefore, in my view, adopting a systemic perspective when looking at services R&D and innovation explains not only how the innovation impacts upon the service firm, but also how a well- built- in service sector or 'service functionality in the innovation system can increase the overall performance of this innovation system considerably.[31]

31 This requires a widened rationale for (service) innovation policies. For a systematic discussion see Janssen et al., 2012.

Figure 1: Three approaches to services R&D and innovation (den Hertog, 2006)

Theory /practice / policy **Approaches**	**Theory of Services R&D and Innovation**	**Empirics & Statistics on Service R&D and Innovation**	**Services R&D and Innovation Policy**
Assimilation Approach	Technological R&D and Innovation is the norm and services are simply less (technological) innovative. Look at the figures!	Technological R&D and Innovation is much lower in services, however variation between industries is large.	No specific policy other than increasing service sensibility of existing generic R&D and innovation policies.
Demarcation Approach	Innovation in services is unique and specific service innovation theories are needed. The peculiarities approach to services.	Major part of innovation in services is non-technological. Service innovation is mostly not managed explicitly.	Specific / vertical service R&D and innovation policies are lacking and much needed.
Synthesis / Systemic Approach	Differentiating between manufacturing and services no longer works. Innovative service functions need to be part of wider innovation systems. A grand unified innovation is much needed.	Service functions are ubiquitous (and intertwined) in services and manufacturing. They play a key role in creating innovative and differentiated products and services.	Services need to be built in into systemic innovation policies paying attention to innovation and 'non-innovation' policies.

Policy options for furthering service innovation[32]

Below a stylised menu-approach or set of policy options is provided available to policy-makers wanting to further service innovation. This simple menu-approach takes the three approaches to services and service innovation as outlined in the previous section as a point of departure.[33]

The assimilation approach – applied to policy-making and according to den Hertog et al. (2008) – can be summarized as a 'no-regret' scenario as it does not imply a specific services R&D and innovation policy. It mainly is about increasing the service sensibility of existing generic R&D and innovation schemes. The demarcation approach as applied to furthering service innovation asks for services-specific R&D and innovation policies. The heterogeneity of the service sector at large, and the peculiarities of some specific service markets, in practice requires specific measures. In the synthesis or systemic approach services are perceived as a systemic dimension of economic activity and thus a potential focus of innovation practically anywhere. Policy initiatives originating from the systemic perspective have passed the services-manufacturing distinction, take a broad approach to innovation and see both R&D and innovation as well as 'non-innovation' policies[34] as vehicles for supporting R&D and innovation. Services are understood not only as an economic sector, but also as a horizontal dimension of the overall innovation system that may boost overall innovation and competitiveness.

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32 For an overview of initiatives and studies that played a role in starting off the discussion on service innovation policies in the first place see den Hertog, 2010, p. 197 and Janssen et al., 2012.

33 This subsection summarises the argumentation included in den Hertog et al. (2006) and den Hertog et al. (2008) and is also included in den Hertog (2010).

34 The importance of other policy areas for innovation, and the need to develop more integrated policies, are argued at length in Lengrand et al. (2002).

A menu of some possible policy options in each of the three approaches is given in figure 2. Here a differentiation is made between R&D and already wider innovation policies, and policies not originally developed to spur R&D and innovation but having a considerable impact on the scope for service innovation (i.e. 'non-innovation' policies).

In my view the current debate on service innovation and service innovation policies is still too much dominated by the assimilation and demarcation perspectives and lacks a vision as to how services can be better embedded in innovation systems, and how innovative services may contribute to the overall innovativeness and competitiveness of these innovation systems. This missing vision is to an important extent due to the persistence of old and new myths regarding the services economy (low productivity, low innovativeness, low tradability; see Gallouj, 2002; Rubalcaba, 2007) and the still predominant 'technological view' on innovation (Gallouj, 2002). Developing the emerging systemic approach further is needed to counterbalance this myopic view, and for developing new and more effective services R&D and innovation policies.

By way of conclusion, it is reiterated here that innovation systems need to be designed in such a way as to cater much better for the needs of service innovators. There are numerous examples of innovative services and service functions (importantly so in manufacturing industries and firms) that are key assets of dynamic and adaptive innovation systems. All businesses in all sectors need service innovation to improve their competitiveness and employment- and wealth-creating capacity. In my view the systemic approach to services R&D is especially most promising, as it recognizes this key role of innovative service functions in developing competitive innovation systems. There is however not one single solution (or "magic bullet"), as for every individual innovation system a (temporary) mix of instruments and policies will have to be developed to suit it. This mix not only depends on the economic structure, history and institutional set up of a particular innovation system, but also on the preparedness and

Figure 2: Examples of assimilation, demarcation and systemic policies aimed at facilitating services R&D and Innovation[35]

	Assimilation policies	Demarcation policies	Systemic policies
R&D policies	• Increase accessibility of existing R&D support schemes • Inclusion of services in technological foresight & road mapping exercises • Include services firms in policies aimed at improving industry-sciences relationships	• Support public R&D in services • Introduce vertical R&D programmes aimed at service industries (logistics, trade, etc.) • Services IPR instruments • Create dedicated Centers of Excellence in services R&D at RTOs and HEIs • Increase role of the humanities in service innovation	• Understand and support role of R&D services (KIBS) in innovation systems • Support for services R&D in and through hybrid firms • Integrated R&D programmes paying attention to technological and non-technological R&D and innovation
Innovation policies	• Increase accessibility of existing innovation support schemes • Innovation management training & practices more geared towards supporting all types of innovation in all industries • Mobility schemes no longer limited to qualified scientists and engineers	• Support public R&D in services • Introduce vertical R&D programmes aimed at service industries (logistics, trade, etc.) • Services IPR instruments • Create dedicated Centers of Excellence in services R&D at RTOs and HEIs • Increase role of the humanities in service innovation	• Innovation & business support systems also supports service innovation • Availability and use of specialised services / KIBS • Increase transparency in KIBS markets • Insight into & international competitiveness of key service functions • Cluster and network type of policies that deliberately include services • Government procurement policies • Support role of users in innovation
Non-innovation policies	• Increase coverage of services in regular and R&D and innovation statistics	• Use deliberately policies such as trade, competition education & training policies for fostering R&D and innovation in services • Regulations that might trigger service innovations • Analyse offshoring in services	• Use regulation & standardisation to support innovation • Financial and credit systems that acknowledge intangible assets • Enhance high level service capabilities e.g. through education & training policies • Policies aimed at increasing entrepreneurship

35 First published in den Hertog et al. (2008).

willingness present among actors in such a system to experiment and invest in mutual learning. Although the emancipation process is slow, the current attention for servitization in manufacturing industries, the rise of service design as a methodology and ongoing policy experiments with service innovation shows that progress is still being made. Eventually, my hope is that service innovation is also seen as part of the solution for big societal challenges such as care for the elderly, sustainable urban living and climate change as they all need not only technical fixes, but also change in human behaviour.

References

Aa, W. van der (2000), *Organisatorische Innovaties en Groeistrategieën van Dienstverlenende Bedrijven*, PhD-thesis Erasmus University Rotterdam, Rotterdam.

Antonelli, C. (1999), *The Micro Dynamics of Technological Change*, Routledge, London.

Boden, M. & I. Miles (2000, eds), *Services, Innovation and the Knowledge-Based Economy*, Continuum Publishers, London/New York.

Coombs, R., & I. Miles, I. (2000), "Innovation, measurement and services: The new problematique", in J.S. Metcalfe & I. Miles (Eds.), Innovation systems in the service economy. Measurements and Case Study Analysis, Kluwer Academic Publishers, Dordrecht, pp. 83–102.

Drejer, I. (2002), Business services as a production function, *Economic Systems Research*, Vol. 14, No. 4, pp. 389–405.

Gallouj, F. (1994). *Economie de l'innovation dans les services* [The economics of innovation in services], Editions L'Harmattan, Logiques économiques, Paris.

Gallouj, F. & O. Weinstein (1997),Innovation in services, *Research Policy*, Vol. 26, No. 4-5, pp. 537-556.

Hertog, P. den (2010), *Managing Service Innovation. Firm-level dynamic capabilities and policy options*, PhD Thesis, University of Amsterdam, Amsterdam.

Hertog, P. den (2006), *Knowledge Intensive Business Services and their role in innovation*, presentation at the OECD workshop on Knowledge Intensive Service Activities, Sydney 22 March 2006.

Hertog, P. den (2000), Knowledge Intensive Business Services as Co-producers of Innovation, *International Journal of Innovation Management*, Vol. 4, No. 4, pp. 491-528.

Hertog, P. den, Rubalcaba, L. and Segers, J. (2008), Is there a rationale for services R&D and innovation policies?', in International Journal of Services Technology and Management, 9(3/4): 334–354.

Hertog, P. den, W. van der Aa, and M.W. de Jong (2010), Capabilities For Managing Service Innovation: Towards A Conceptual Framework, Journal of Service Management, 21 (4), 490-514.

Hertog, P. den, Bilderbeek, R. & S. Maltha (1997), Intangibles: the soft side of innovation, Futures, Vol. 29, No.1, pp. 33-45.

Hertog, P. den, Bouwman, H., Gallego, J. , Green, L., Howells, J. Meiren, Th., Miles, I., Moerschel, I., Narbona, A., Rubalcaba, L., Segers, J. & B. Tether (2006), Research and development needs of business related service firms, final report to European Commission, DG Internal Market and Services, Dialogic/Fraunhofer /PREST/Servilab, Utrecht/Stuttgart/Manchester/Madrid.

Hertog, P. den, L. Rubalcaba & J. Segers (2008), Is there a rationale for services R&D and innovation policies?, International Journal of Services Technology and Management, Vol. 9, No. 3-4, pp. 334-354.

Hipp, C. & H. Grupp (2005), Innovation in the service sector: the demand for service specific innovation measurement concepts and typologies, Research Policy, Vol. 34, No. 4, pp. 517–535.

Howells, J. & B. Tether (2004), Innovation in Service: issues at stake and trends, Study for DG Enterprise, Commission of the European Communities, Brussels.

Janssen, M. (2015), Service Innovation in an evolutionary perspective, PhD thesis, Technical University Eindhoven, Eindhoven.

Janssen, M. and P. den Hertog (2016), "Developing service-based business models: Which innovation capability for which innovation dimension?", in Toivonen, M. (Ed.), *Service Innovation*, Volume 6 of the series Translational Systems Sciences, pp 97-12, Springer.

Janssen, M., P. den Hertog en B. Kaashoek (2012), *Service innovation policies. Rationales, strategies, instruments*. Study commissioned by OECD, Dialogic, Utecht

Lengrand, Louis & Associes, PREST & ANRT (2002), *Innovation Tomorrow. Innovation Policy and the Regulatory Framework: Making Innovation an Integral Part of the*

Broader Structural Agenda, Innovation papers No 28, DG Enterprise, EUR report no. 17052, Brussels.

Metcalfe, S. & I. Miles (eds) (2000), *Innovation Systems in the Service Economy: Measurement and Case Study Analysis*, Kluwer Academic publishers, Dordrecht.

Miles, I. (2005), Innovation in services, in: J. Fagerberg, D. Mowery & R. Nelson (Eds.), *The Oxford handbook of innovation*, Oxford University Press, Oxford, pp. 433-458.

Miles, I. (1999), Foresight and services: closing the gap?, *The Service Industries Journal*, Vol. 19, No. 2, pp. 1–27.

Muller, E. (2001), Knowledge, innovation processes and regions, in K. Koschatzky, M. Kulicke & A. Zenker (eds.), *Innovation Networks: Concepts and Challenges in the European Perspective*, Physica- Verlag, Heidelberg, pp. 37–51.

Miles, I., N. Kastrinos, R. Bilderbeek, P. den Hertog with K. Flanagan & W. Huntink (1995), *Knowledge-intensive business services: their role as users, carriers and sources of innovation*, Report to the EC DG XIII Sprint EIMS Programme, Luxembourg.

Nählinder, J. (2002), *Innovation in KIBS: State of the art and conceptualisations*, Arbetsnotat, No.244, Linköping.

OECD (2012a*), Knowledge-based capital and upgrading of global value chains*, April 17, 2012. Working party on Globalisation of Industry, DSTI/IND/WPGI (2012)2, OECD, Paris.

OECD (2012b), *The Rise of Global Value Chains.* Draft synthesis report on global value chains – chapter 1. September 24, 2012. Working party on Globalisation of Industry, DSTI/IND/WPGI (2012)17/CHAP1, OECD, Paris.

OECD (2006), *Innovation and Knowledge-Intensive Service Activities*, OECD, Paris.

Preissl, B. (2000), Service innovation: what makes it different? Empirical evidence from Germany, in J.S. Metcalfe and I. Miles (eds), *Innovation Systems in the Service Economy: Measurement and Case Study Analysis*, Kluwer Academic Publishers, Boston (MA), pp. 125–148.

Rubalcaba, L. (2007), *The New Services Economy: Challenges and Policy Implications for Europe*, Edward Elgar, Cheltenham.

Rubalcaba, L. (2006), Which policy for innovation in services?, *Science and Public Policy*, Vol. 33, No. 10, pp. 745–756.

Rubalcaba, L. (1999), *Business services in European industry: growth, employment and competitiveness*, Office for Official Publications of the European Community, European Commission, Luxembourg.

Rubalcaba, L. & H. Kox (2007, Eds.), *Business Services in European Economic Growth*, Palgrave Macmillan, London.

Sirilli, G. & R. Evangelista (1998), Technological innovation in services and manufacturing: results from Italian surveys, *Research Policy*, Vol. 27, No. 9, pp. 882–899.

Sundbo, J & Gallouj, F. (2000), Innovation as a loosely coupled system in services, in: Metcalfe, J.S. & I. Miles (Eds.), *Identifying Innovation systems in the service economy, measurement and case study analysis*, Kluwer Academic, Dordrecht, 43-68.

Tether, B. (2005), "Do services innovate (differently)? Insights from the European Innobarometer Survey", Industry and Innovation, Vol. 12, No. 2, pp. 153–184.

Wood, P.A. (2001), *Consultancy and Innovation: The Business Service Revolution in Europe*, Routledge, London/New York.

Young, A. (1996), *Measuring R&D in the Services*, OECD Science, Technology and Industry Working Papers, 1996 (07), OECD, Paris

Zenker, A. (2001), Innovation, interaction and regional development: structural characteristics of regional innovation strategies, in K. Koschatzky, Kulicke, M. & A. Zenker (eds), *Innovation Networks: Concepts and Challenges in the European Perspective*, Physica- Verlag, Heidelberg, pp. 207–222.

Mission-oriented innovation policies 2.0[36]

On public leadership in innovation & white elephants

Patries Boekholt

Introduction

This short paper addresses the thinking about the public-private relationships in innovation policy and in particular the utilisation of 'Big Missions' as a policy vehicle to achieve big impact. The paper aims to describe how this relationship has been positioned in the last decades, and how this relationship is likely to transform in the future. At the time that Walter Zegveld was director of the Centre for Technology and Policy Studies at TNO, Big Missions had a clear role, particularly in industry oriented technology policy. Large scale initiatives such as supporting Airbus and the ESPRIT programme to create European industries were already on its way out of the policy arena. From the 1990s supporting Big Missions became politically less attractive and replaced by generic of technology oriented policy support programmes. Today Big Missions are back in the centre of debate. This paper looks back at what Big Mission policies looked like and links this to today's debate on the need for Big Missions or 'Moonshots' as they are labelled now.

36 This paper is an adaptation of an article written for the 6CP conference in Vienna on 24/25 March 2015.

Those who have been active in innovation policy long enough (even if shorter than 40 years) can recognise recurrent waves of dominant approaches in innovation policy. The form and height of the waves depend from which national shore you look at innovation policy, but in broad lines we have seen the pendulum swinging several times:

- Between a policy portfolio dominated either by mission-oriented and thematic policy instruments or by the indirect and horizontal policy instruments

- Between systemic and holistic innovation policy concepts to piecemeal management of a set of individual instruments

- Between a dominant discourse on an active and visible public-private interaction to achieve innovation goals and a discourse of an entrepreneurial and market driven innovations with little state intervention

The focus on market failure and a neo-liberal hands-off approach, fuelled by the austerity reaction to the economic crisis, seem to have dominated the last decade of innovation policy in many – but not all – European countries. At the same time, there are signals that there are protagonists in the policy arena that wish to move back to more hands-on 'industrial policy' concepts.

Can we simply swing back the pendulum and go back to the type of direct R&D policies that were sector focused and in many ways 'mission oriented? This paper argues that there are too many changes in the context of innovation policy that ask for a drastic rethink on the governance of innovation policy and the role of the state, as well as the type of instruments that need to be applied. In addition, the type of missions policy makers are seeking today are no longer solely industry policy oriented but focused on addressing societal challenges.

Mission-oriented policies old style

It was back in 1986 when Henry Ergas distinguished mission-oriented countries, in the sense of primarily concerned with major projects of national significance (e.g. US, UK and France) and diffusion oriented countries, being largely concerned with upgrading the capacity of firms to respond to new technologies (e.g. Germany, Switzerland and Sweden).[37] The big missions the former type of countries engaged in were mostly military and defence related big projects, where the public sector had a leading position particularly through public procurement. It was always argued that this type of big military investments was also beneficial for the rest of the economy through the 'trickle-down' mechanism, reasoning that eventually the technologies will end up in non-defence products.

It was Anna Lee Saxenian (1996) who demonstrated the impact of decennia of these large-scale defence related public investment and contracts on the rise and growth of Silicon Valley and particularly the ICT sector in that region.[38] More recently Mariana Mazzucato has linked this defence related public investment to the strong ICT sector in the US, and indirectly leading to the success of Apple's iPhones.[39] So the trickle-down concept seems to work albeit with a huge time lag and with difficulty to predict where it will land.

Meanwhile, in Europe we started in the 1980s with a different type of mission oriented innovation policies: supporting the European 'Champions' in electronics, transport, aviation, through large scale programmes at Euro-

37 Ergas, Henry, (1986) Does Technology Policy Matter? Centre for European Policy Studies, CEPS Papers No. 29

38 Saxenian, Anna Lee, (1996), Regional Advantage, Culture and Competition in Silicon Valley and Route 128, Harvard University Press, Cambridge, Mass

39 Mariana Mazzucato, (2014) The Entrepreneurial State, Debunking Public vs. Private Sector Myths, Anthem Press, London.

pean level (e.g. ESPRIT, Airbus) and at national level. These were aimed at keeping strategic national industries globally competitive. In this sense Europe's mission-oriented policy was very much an industrial policy, which had moved on from a defensive industrial strategy - keeping large failing companies open to save jobs - to an offensive strategy: providing core companies with support to innovate and invest in R&D and become global competitors.

Some countries were more active at this at national levels (France, Germany, Netherlands, Finland) than others (UK, Switzerland). This type of innovation policy was clearly intended as industrial policy, but with state aid rules in mind, using technology as the commodity (funded through grants or through publicly funded research institutions) between state and private sector. The mission-oriented policies were very sector oriented and focused on a number of key corporations with high R&D-intensity. Keeping them embedded in Europe was the main policy concern. The policy instruments were mostly defined in technological terms such as for instance the multi-annual Micro-Systems Technology programmes in Germany or the Netherlands' electronics stimulation policy or the various generations of Telecommunication Technology programmes in Finland. Obviously not all EU countries had big champions so trying to attract them from abroad was another strategy (e.g. Ireland attracting US ICT companies, Flanders with its first attempts to co-invest in a micro-chips factory in the early 1980s).

The dominant policies in this first-generation industrial innovation policy were mostly large thematic research and technology programmes with co-funded R&D projects for single or groups of companies often in partnership with public sector research centres and universities. The public –private relationships in this era was one where policy makers and (big) industry seemed to share the same vision for the future where large-scale R&D investments needed be co-funded in order to ensure competitiveness of key sectors. Industry also took its role to invest in strategic and sometimes even fundamental research in house, what was then still mostly a 'closed innovation' model.

So, did these policies achieve to embed the national champions and make them more competitive? The innovation policy evaluation community knows how difficult it is to attribute effects of single policy programmes and projects to socio-economic impacts, at micro-level (e.g. participating companies), meso-level (e.g. the automotive industry in Europe) let alone on a macro-level. The problem is that in depth evaluations are mostly commissioned on one particular technology policy programme, assuming to find an effect from project X on company Y in country Z. Rarely are studies commissioned that take into account the longer-term effect of a set of policies that could have an impact on the performance of a particular sector or set of companies operating in a global environment. Fact is that from the few longer-term studies available these thematic mission-oriented policies seem to have had an effect in the past decades. What would have happened without these policies is hard to determine as there is no counterfactual evidence available.

A number of studies conducted by the Technopolis Group have approached the question of impact on industry from a long-term perspective. The successive European Framework Programmes for instance have played a large role in the European automotive sector. In the Automotive Industry**,** the Framework Programme's role has been to sustain longer- term research and development in areas such as fuel efficiency, emissions and safety that create not only private advantages for the industry but significant public goods. Exploiting the industry's desire to self-organise to define R&D directions and road maps has been a powerful way to coordinate the longer-term R&D effort and has supported a long series of product and process innovations that help maintain Europe's position among the global leaders in this industry.[40] A 2001 evaluation on the effects of the large scale EUREKA programmes on the European electronics sector also showed that the effects of these policies go beyond the mere R&D funding and have effects through research agenda setting and standardization by

40 Erik Arnold, et al (2011) Understanding the Long Term Impact of the Framework Programme, EPEC consortium, Technopolis Group, Brighton.

means of R&D collaboration that would not have taken place outside the realms of a government programme.[41] In another long-term impact study Erik Arnold and colleagues found how Swedish state-funded R&D had a strong impact on the Swedish telecommunications industry and in particular Ericsson and the setting of the GSM standard.[42] In Finland a review by Rambøll showed that five TEKES Telecommunication programmes between 1997 and 2010 had a positive impact on the telecoms business sector, but then the crisis of 2008 hit the industry and everything changed.[43]

The examples of Taiwan, South Korea and Singapore show that, with quite some endurance, a 'catching up' strategy, by protecting internal markets, 'aggressively' supporting the emergence of a limited number of high tech industries and a focused science and technology policy, can also work. But other countries that tried this recipe were less successful.

Even Europe has been battling its own 'catching up' strategy with the USA and more recently with China. Replicating the success of the Asian Tigers in the increasingly globalized world and with the open European economies has proven to be difficult, although in some industries (e.g. Automotive) Europe is doing better than the USA in terms of R&D investments. A key policy question today is that while these large-scale missions might have worked in the past for certain sectors, will these type of big scale R&D subsidy policies work today and in the future? But first most of Europe went

41 Patries Boekholt, et al. (2004), Mid-term Assessment of the Eureka Programme MEDEA+, Technopolis Group and VDI/VDE-IT, Amsterdam, (Public summary version available only).

42 Erik Arnold, Barbara Good and Henrik Segerpalm (Technopolis Group), The GSM Story, Effects of Research on Swedish Mobile Telephone Developments, Vinnova, Stockholm, 2008.

43 Annu Kotiranta, Olli Oosi, Mia Toivanen, Jaakko Valkonen and Mikko Wennberg, (2011) Cooperation to Create Converging and Future Networks – Evaluation of Five Telecommunications Programmes, Tekes, Helsinki.

through a policy period where these type of big mission industrial policies became highly suspect.

The upswing of a neo-liberalist approach to innovation policy

The industrial policy old style was heavily criticized for 'picking winners' and more seriously, picking the wrong winners and thus creating some famous white elephants (e.g. Minitel, HDTV, Concorde, ...). These big White Elephants are politically much more visible than for instance decades of ineffective R&D tax reliefs with limited additionality. Even the counter argument that these policies were backing winners rather than picking winners was not accepted everywhere.

The 'big mission' aspect of these industrial policies – supporting mostly the large R&D intensive corporations - became more or less 'suspect' in the course of the 2000s when:

- Public policies were needed to be seen to solely tackle market failures after the upsurge of neo-liberal economic policies, which heavily argued against the danger of 'picking the winners'. It is probably the United Kingdom, The Netherlands and Switzerland that went furthest in that policy approach.

- The European Champions became global players and off-shored manufacturing and increasingly also R&D to other continents and entered into strategic alliances with former US and Asian rivals. So it was more difficult to defend direct R&D supports from the national or European interest angle

- More policy attention was paid to SMEs and new start-up companies rather than big corporations, when it became clear that growth and innovation were not necessarily coming from the large corporations.

> Here 'Old Europe' looked at the USA again and tried to emulate the dynamic start-up sector that created the new growth companies.

Indeed, quite a number of the European Champions do not exist anymore, have split up in a number of diversified companies (e.g. Siemens and Infineon, Philips and NXP) or purchased by investors from outside Europe (e.g. Nokia).

In varying degrees and at different paces European attention shifted to generic policies (fiscal policies), and non-thematic R&D grant programmes. A number of countries tried to copy what is generally seen as successful US Small Business Research and Innovation Programme (SBIR), however without a similar scale and generosity of grants. Cluster policies that came into vogue in the 1990s appeared mostly on regional policy agenda's and focused on relatively small scale and fragmented regional eco-systems. It wasn't until the mid-2000s when they appeared back again on some national agenda's (e.g. the French Pole de Competitivité launched in 2004) with some resemblance to the old industrial policy approach, embedded in a place based eco-system.

While the rhetoric of the market driven – hands off policy approach was the loudest in the last decade or so, in reality many of the advanced EU countries continued with technology driven programmes that catered for the specific national R&D intensive manufacturing and pharmaceutical industries. So, we could argue that in countries like Germany and France the industrial innovation policy never really went away.

In smaller EU countries, the policy instruments became more sophisticated. Rather than large scale thematic R&D programmes, instruments that promoted more structural public-private partnerships such as competence centres were established in Sweden, Norway, The Netherlands, Austria, Flanders, Estonia, Ireland, Spain and more recently also Finland. One reason why this was seen as necessary was that a large part of in-

dustry was retreating from fundamental and strategic research, both in house and contracted out. In addition, after off-shoring manufacturing the off-shoring of R&D capacities is still on the rise. And only few European countries managed to attract R&D investment from outside the continent.

Big-mission oriented industrial policies can only work if both parties - public and private - keep working on increasing their R&D investments and sharing common visions for the long-term direction of the research agenda. This seem to have eroded in the first half of the 2000s. But in times of crisis the industry oriented Big Missions find their way back on the policy agenda.

When the economic crisis hit Europe in 2007 Commissioner Barroso launched an economic crisis package with the Economic Recovery Plan (2008) including a number public private partnership programmes to support industrial R&D in a number of sectors such as the automotive sector (Green Cars), the building sector (Energy Efficient Buildings) and advanced manufacturing (Factories of the Future). A total financial envelope from the EC was foreseen of €7,2 billion for these three projects. While all three initiatives are industry oriented, at least the first two had societal challenge element in them as goal was set in terms of reducing the carbon footprint.

Mission-oriented policies new style

The socio-economic and technological context has changed

There are some signals that Industrial Policy is back on the economic growth agenda and thus also defining the innovation policies of tomorrow. So, this raises the question can we expect that the Old Style Industrial policy support strategic sectors and champion companies will be back? Or has the context in which economic and innovation policies operate changed too much?

There are a number of factors that have changed in the context of traditional innovation policies and will likely have a huge effect on their potential impact:

- The world has globalised and new players have appeared on the innovation horizon that change the international game: China, South Korea and to a lesser degree India. The large R&D intensive (European) corporations are participant in this internationalisation trend and after a wave of off-shoring manufacturing, the off-shoring and internationalisation of research and innovation is a given fact. Capturing the economic benefits from domestic (publicly financed) research and innovation becomes even more challenging;

- Innovation and technological breakthroughs happens more and more on the cross-roads of sectors, applications and technologies, so the solely sectoral or single technology programmes and institutions of the 1980s and 1990s seem to be obsolete

- The 'disruptive' innovators and fast growth companies, combine existing (mostly ICT-based) technologies with new business models and/or better customer experiences. It is less likely that traditional R&D support programmes spur these types of innovations. Their success depends more on adapting regulations in favour of the market introduction of these innovations

- The behaviour of (big) industry towards R&D has changed with a larger pressure on demonstrating return for investments on R&D and by adopting an open innovation model

- The large and complex issues related to societal challenges require a transformative innovation policy aiming for structural systemic changes and experimentation (see for instance Schot and Steinmuller, 2016)[44]

44 Schot, J., and Steinmueller, E. W. 2016. Framing Innovation Policy for Transformative Change: Innovation Policy 3.0. SPRU Working paper.

The nature of the 'big mission' has changed

Obviously improving competitiveness and stimulating economic growth are still core elements of innovation policies in all European countries and at EU level (e.g. Europe 2020). But new missions have entered the stage:

- The Grand Societal Challenges, an agenda first set by the European Commission and gradually taken on board by many member states and regions

- Inclusive growth – tackling the disparities in wealth within Europe and also globally

It needs no lengthy argumentation that the contribution of science and innovation to the Grand Societal Challenges has become an important mobilising factor for defining innovation policy goals. The Societal Grand Challenges (GCs), were identified in the Lund Declaration[45] and are now at the heart of *Europe 2020*[46] which is specifically directed towards systemic change in order to solve societal challenges including climate change/ global warming; ageing population; public health; pandemics; safety and security; energy, food and water supplies. With regard to these GCs, the European Commission's *Horizon 2020*[47] identifies a pivotal role for research and development and states *"smart investment, notably in research and innovation is vital in order to maintain high standards of living while dealing with pressing societal challenges"*[48].

H2020 has, support for research to tackle societal challenges (with seven domains) as one of its three pillars. Of the three pillars it receives the largest amount of research funding with €29,7 billion, (other two are excellent science (€24,4 billion and industrial leadership €17 billion).

45 July 2009

46 European Commission, COM(2010) 2020

47 European Commission, COM(2011) 808

48 Ibid., pg. 2.

This shift towards societal missions does not necessarily mean that the public-private relationship alters drastically. In quite some sectors the concern for sustainability, energy preservation, health is also translated into commercial goals and into new innovative products. It simply provides public sector agents with an additional set of criteria to prioritise public investments in R&D. It also means that in the design of policies additional sets of stakeholders (e.g. users, civil society, patients, environmental organisations) need to be involved to ensure that policy instruments are effective in stimulating innovations and addressing the societal issues.

Are we still tackling new style missions with old style policies: i.e. technology focused R&D subsidy programmes – supply side policies - catering mostly for the incumbent industries? Increasingly national and regional governments have followed to take these societal challenges as the key mission for innovation policy, in conjunction with improving competitiveness of the private sector. For instance, Finnish Tekes programmes are now called "BITS for Health" and "Green Growth". The German Ministry BMBF calls one of its lead policy projects "The CO2 neutral, energy efficient and climate change adapted City". This type of labelling of the mission of the policies is quite different than the technology and or sector specific programmes of two decades ago. Is this just the label and do these programmes still do the same old R&D projects with the incumbents as they did before? This is difficult to judge without an in-depth evaluation. However, the mind-set of what these programmes aim to achieve is clearly quite different.

Are we seeing a comeback of Industrial Policy as we knew it?

Alongside the upsurge of these societal missions as a lead for science and innovation policy there are also signals that call for a comeback of industrial policy in Europe. The economic crisis hitting many industries and

the fact that across the board BERD is not really improving could be some explanations.

In 2014 the European Commission published a Communication with the title *'For a European Industrial Renaissance'*.[49] The title would suggest that industrial policy is back in vogue. The term *industry* in this policy paper is understood as the manufacturing sector. The accompanying staff working paper identifies the sectors that need policy attention: Chemical, Automotive, Machinery, Forest-based Industries, Steel, Non-ferrous metals, Textiles (fashion and high end), Defence, Space, Agri-Food industries, Pharmaceutical, Bio-based Products, Cement, Ceramics, Glass, Construction and Tourism). This looks very much like a list that could have been drawn up in the 1970s with the exception of bio-based products. So, we can consider this approach as either hugely outdated or simply very realistic given how employment is distributed in Europe.

Its predecessor Communication of 2010[50] states that a new *industrial innovation policy* is needed to encourage the much faster development and commercialisation of goods and services and to ensure that EU firms are first onto the market. This new industrial innovation policy would be a mix of horizontal policies (e.g. standardisation, regulation, internal market, finance, skills), technological support (in particular for Key Enabling Technologies) and keeping in track with societal challenges (sustainability in particular). The Key Enabling Technologies approach is probably the most sensible way of supporting the development of platform technologies that can be taken up by companies in a variety of sectors and value chains.

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49 European Commission (2014), For a European Industrial Renaissance, Brussels, COM(2014) 14/2

50 European Commission, (2010) An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage, Brussels COM (2010) 614.

What mostly reminds of old style industrial policies is the following statement in this Communication:

> "Delivering the new industrial policy also calls for more effective European governance. The concepts of national sectors and national industries with little interaction with other sectors or the rest of the world are becoming less relevant. It is now increasingly important to identify strategic European industrial interests, and uncoordinated national policy responses must give way to coordinated, European policy responses." (p. 31)

However, the accompanying mechanisms and governance arrangements to identify and define 'strategic European industrial interests' are not described in the document. The newly appointed European Commission does seem put Industrial Policy at the core of their growth strategy and aims to bring the share of manufacturing back to 20% of GDP by 2020 (from 15,1% today).

Another initiative that could hint at a revival of Industrial Policy is the 'Top Sector Policy' introduced by a new government in 2012 in The Netherlands. Through a not very transparent process, the government choose nine sectors[51] that would receive government priority in the future. This new policy also meant that a majority of existing R&D subsidy programmes, mostly thematic collaborative public-private partnership type of programmes was terminated. Simultaneously, the fiscalisation of R&D policy was augmented with the creation of new tax credit programmes. One reason that was put forward by the government was that the private sector was not really pulling its weight in these programmes, showing a free rider behaviour and hardly funding more than 25% of these initiatives. In the new approach, the private sector was stimulated to draw up long term R&D

51 This list includes the Chemical Sector, Agro-Food, Energy, Creative Sector, High-Tech, Logistics, Life Science & health, Horticulture and Water.

contracts with the public sector research organisations, however without any additional state funding. Another reason was the strong neo-liberal position of the (current) government that industry is in the best position to choose how to invest in R&D, governments should not interfere. The government gave a number of 'Czars' from industry a free role to define the common research agenda with the public-sector institutes. The latter position was highly criticised for instance by regional stakeholders who stated that the national government didn't take the Triple Helix serious anymore as it simply retreated as a partner. [52] So the choice of sectors as the key target group for policy suggests that this is 'old style' industrial policy, the lack of big scale thematic (R&D) instruments however reveals that it is not the case.

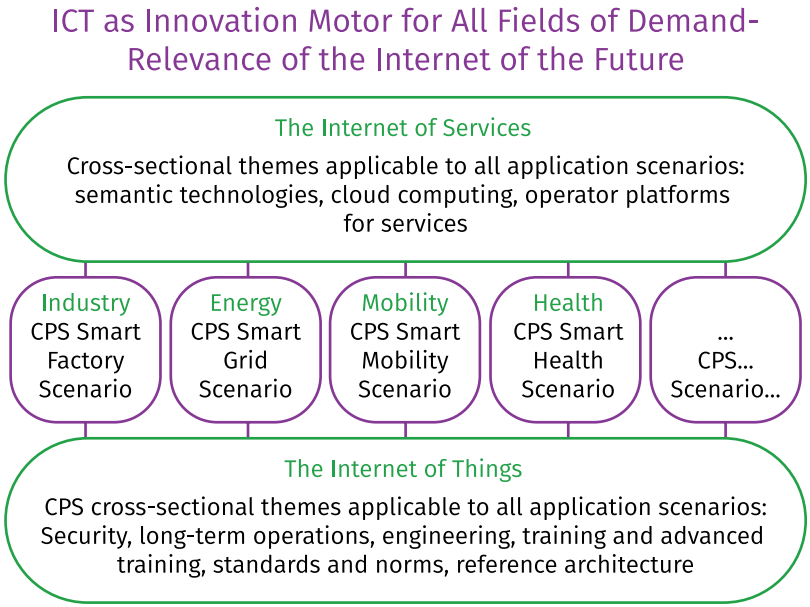
Last year's key policy initiative in *Germany* called Industry 4.0 also gives the impression of a new spirit in Industrial Policy. In reality it has been an evolutionary process in the German High-Tech Strategy development that stated off with defining technologies and sectors in the early years of policy formulation, but has evolved towards more cross cutting themes.

What makes the German approach more in line with the new requirements of today's new missions and challenges is the clever combination of fields of demand (smart factories, energy, mobility, health), manufacturing (the Internet of Things) and the Internet of Services. So this approach caters for the innovations coming from the combination of technologies with ICT as a key platform technology that can support other innovations. It does not prescribe particular sectors (although of course behind the 'fields of demand' are key sectors) and it includes the horizontal aspects of training, standards etc. The Plan has identified lighthouse projects that will be pursued over a 10 to 15 year time frame. So the plan is ambitious, has

52 See Patries Boekholt, Derek Jan Fikkers, Stijn Zegel, Martijn Poel, Frank Zuijdam (2014) Verschuivende Paradigma's in het Regionaal Economisch Beleid (Shifting paradigms in Regional Economic Policy), Technopolis Group, Amsterdam

considerable government and private sector backing in terms of investments and has a long term scope. Whether the lighthouse projects and joint investments will really involve new players and move away from the incumbents remains to be seen.

Figure 1 Industry 4.0 in Germany



Some would argue that the emergence of *smart specialisation strategies* (S3) can also be seen as a signal of the comeback of industrial policy. A key concept in the smart specialisation strategy is the prioritisation of public sector research and innovation investment to a limited set of domains or

target groups. Another central concept is the choice for existing economic strengths as the starting point for the regional economic restructuring and diversification. Indeed, if implemented badly, the combination of the two could lead to conservative sector policies, favouring for instance those sectors with largest employment, even though they have a limited future in terms of innovation and growth. Or alternatively, it could lead to the choice of large public investments in 'me too' technologies without any local absorptive capacity to turn this into commercial successes. However, this would mean a misconception of what smart specialisation set out to be, namely using robust evidence, transparent processes and strategic planning tools to explore new technological and market opportunities that can help the region to become more competitive. An essential element of this S3 approach are extensive stakeholder processes between the public and private sector, avoiding that only the incumbents have a say in the choices for experimentation. Unfortunately, the strategic capabilities, the human capacity and relevant expertise are not always available for a smart implementation of S3.

To sum up there are indeed some signals that would suggest that industrial policy is back on some policy agendas. However, there is little evidence that any government is considering the old style large-scale big-mission, top-down government led choices in favour of a limited set of European or National Champions. That model simply doesn't work anymore in the current context.

What next: mission-oriented policies 2.0?

We can find the arguments and prerequisites for a new style mission-oriented policies in many articles, policy documents and even in quite some government programmes. So why aren't we seeing this really implemented in policy practice, not in Europe and not in the USA either? This requires a number of changes to the 'business as usual' model:

1. We need to go *beyond the single sector and/or narrowly defined technology programmes* and develop programmes and research organisations geared to making cross-sectoral and cross-technological connections. If the development of new technologies and innovations requires partners from other countries to access complementary knowledge not available locally then this should not be hampered by administrative borders

We should not simply abandon all old-style innovation policies: we continue to rely on public investment in basic, strategic and applied research, also in targeted 'strategic domains' to create the necessary technology platforms for a wide set of innovations. We still need the skills development in these scientific and technological domains if only to ensure there is sufficient absorptive capacity to use these technologies. But programmatic and institutional walls between different technological and application domains need to be brought down, particularly when they are purely administrative (e.g. Agency A is responsible for programme B so no interaction is allowed with programme C run by Agency D)

That also means that private sector partners need to position themselves in (international) value chains to identify potential partners and look at entirely different sectors to explore opportunities for diversification.

2. Policies still neglect the role of *non-technological components of innovation* such as business model innovations, service innovations, design, legislation, regulation and standardisation.

This is still an underexposed area of innovation policy analysis. There are a number of countries that have good and bad policy experiences with tackling a number of these non-technological aspects of innovation. They should be disseminated across the policy community to define good practices.

3. With regard to launching the potential Big Missions that address Societal Challenges most governments are not really taking up an *ambitious leading role* using a combination of regulation, public procurement, market incentives, R&D stimulation, risk capital, skills development and so on to support paradigm shifts and new business niches in areas such as climate change, health, sustainable energy and other societal challenges

In risky markets, where new technologies could help address societal issues, and where the private sector is not willing to invest, governments could play a leading role with *stronger demand side policies* - shaping the market through regulations and/or creating demand and first mover advantage as launching customer. Demand side policies are nothing new and the innovation policy arenas have been talking about implementing it for over a decade. Yet we do not see many bold initiatives to tackle this on an ambitious scale. Policy is getting more and more political, run by politicians with a short-term agenda and a fear of engaging into risky projects.

The UK has embraced the Small Business Research and Innovation programme (SBRI) and has numerous calls for mostly small-scale innovations contracted by public sector authorities. In the Netherlands, a similar programme has been reduced to a very small scale existence due to austerity measures. We can see many regional governments piloting and testing innovations such as in the domain of eHealth. Interesting initiatives are started around Smart Cities. But the opportunity to scale these local initiatives up and stimulate fast growth companies or even market new niches that have a global impact have not surfaced yet. They rarely end up as the disruptive technologies that we have seen lately (e.g. Uber, AirBnB, ..).

Perhaps the announced Juncker Investment Plans will become these ambitious public investments for the future? At this stage, the process of se-

lecting the large-scale investments topics is not very transparent and the first suggestions for investments do not sound as innovative game changers. The fact that budgets are being taken from Horizon 2020 for these plans is currently dominating the debate, rather than the question what could be done with this investment plan.

Mariana Mazzucato's (2014) book on the Entrepreneurial State makes a strong argument for this active and bold role of the state. In her view, this entrepreneurial state needs to be built with institutions and organisations that are able to create long-run growth strategies and welcome the inevitable failures that this will entail. The really ambitious role would require a systems approach rather than the usual R&D project by R&D project approach. Scholars in the environmental and sustainable energy domain have pleaded for *systemic transitions* for quite some time now, but the economic powers of the incumbent technologies have proven to be very strong (see for instance various articles by Frank Geels). Nevertheless, Mazzucato describes a number of success stories in wind and solar power through active leadership in for instance China and Germany.

4. A multi-faceted approach of pushing for new directions and systemic transitions needs a *holistic governance approach* to research and innovation

Another key ingredient that is still weakly developed is a genuinely holistic governance approach to support long term innovation, tackling the supply side (research and technology, education) the demand side (potential launching customer role), the regulatory and legislative side, the infrastructure side (investing in the big scale infrastructures and networks from which the private sector stays out) and the facilitation side (setting long term visions, facilitating public-private research agenda's and roadmaps).

Not only does this need a new type of governance within government (and between multi-level layers between cities, regions, nations and the EU).

It needs a systematic dialogue and strategy formulation with the private sector and societal stakeholders to ensure policies will be taken up and have the foreseen effects. While we have created various tools in the past (foresights, roadmaps, societal dialogues, ...) we seem to be reinventing wheels all the time.

We should start to envisage that innovation policy is no longer defined by the departmental 'silos' of the Science and Innovation Departments or the Industry and Innovation Departments. But what is the alternative? A whole set of (fragmented) Task Forces operating between say the Innovation Ministries and the Health Ministries to support innovations that address the Ageing Society issues? So, decentralisation? Or more coordination from the top? We know from experience that overarching National Research and Innovation Councils, (headed up by Prime Ministers) can have some success, (the early years in Finland) but can also fail to deliver any structural change (such as similar initiatives in The Netherlands and Ireland). Defining the new governance model for Mission-Oriented Policies 2.0 is a real challenge for the innovation policy community that has been conveniently locked into its departmental boxes for the past four decades.

5. A private sector that is committed to engage in the dialogue with the public sector to define medium and long-term agenda's and subsequently invest in the R&D to achieve commercial success from taking bigger risks

Not only politics suffers from short-termism. The business reality of the private sector with more pressure from investors and shareholders has also made them shy to invest in medium to long-term developments. Mazzucato criticises the 'skewed reality of risks and rewards' where governments take the biggest risks, industry takes the biggest rewards but fail to pay corporation taxes on these rewards. Policy can't easily change the global market dynamics. The role that governments can play in this is to provide long-term security on policies and regulations that will help shape the new Big Missions.

Big missions in the EU framework programme 9

As if almost out of the blue, mission oriented policy today has returned at the heart of innovation policy debate. A high-level expert group that looked at the overall results of the Horizon 2020 programme mid-term evaluation concluded that we should become better at maximising the impact of EU Research and Innovation. Despite decades of talking about the 'European Paradox' (good at science but bad in transferring that into innovations) even today's multiannual research programmes do not have impact on economic growth at a sufficient scale, according to this report. As a remedy for this shortcoming, the Lamy report suggests a revival of mission-oriented research, particularly by means of large scale missions. These missions should be focused on major societal challenges according to the report. The advice of this expert group has certainly caught the attention and indeed lively discussions are taking place what these missions could look like.

The focus on societal challenges is not a new phenomenon, the focus on societal challenges is already a key element of the EU's mission orientation as mentioned above. The 'new' element in Lamy's report is the 'policy mechanism' of 'big missions' with a view to create higher impact and attract the attention of the wider public. The current list of societal challenges in H2020 provide a wide spectrum of candidates for good topics for big missions. The question what 'big mission' would need new governance mechanisms to prioritise which one to choose.

The element that is still missing in the debate is the implementation questions: how will big missions be different in terms of policy support? Is it sufficient to dedicate even more research funding to a particular topic? That seems to be the approach of the USA's 'moonshot' project launched under president Obama: the National Institute of Health's cancer moonshot which was awarded a $1.8 billion funding for cancer research with the goal to deliver a decade worth of cancer prevention, diagnosis and treat-

ment in just 5 years. So, in this case big means more research funding, also in partnership with the pharmaceutical industry.

The question for the European context is whether, with its lasting European Paradox, more research funding to one particular societal challenge is going to create the larger scale societal and economic impact that the Lamy report was suggesting we need. The report hints at how EU research and innovation funding should be different:

- missions should privilege impact, they should define a clear goal which captures public imagination, and they should mobilise many different actors. The report suggests using the UN Sustainable Development Goals to frame large-scale R&I missions

- It suggests a better alignment between EU and national for the purpose of the missions.

In today's policy discussion, there is however little clarity on what type of policy instruments are needed to deliver Big Missions and one could have the impression that it is all a matter of spending bigger amounts of research and innovation funding to one dedicated topic, in line with for example the US Cancer Moonshot. One thing we can learn is that technological successful and big achievements (e.g. Concorde or Minitel) are not necessarily in line with what markets or societies demand. Given the complexity of the societal challenges, bigger impact asks for more systemic changes and not just a number of novel artefacts. Stakeholders, users and civil society in general should be much more involved in defining the problems that need most urgently addressed and the goals that should be aimed for.

Research and innovation funding alone is not sufficient to ensure the adaptation in markets and society. It asks for other policy domains (e.g. energy, health, agriculture) and instruments (e.g. regulation, public procure-

ment) to be mobilized for the same big causes. In the transition process to implementing Big Missions we should experiment with joined up initiatives that have clear targets that go beyond expected research outcomes. EU member States and the European Commission have an urgent opportunity to 'co-design' a new policy approach in the preparation of FP9. Learning from successes and failures of Mission-oriented Policies 1.0 is a necessary first step.

Complementing technological innovation with workplace innovation

Frank Pot[53]

Reindustrialization in the 1980s

In the 1980s Walter Zegveld was one of the important contributors to the debates on industrial policy. Opposing the idea of 'post-industrial society' Rothwell and Zegveld (1985) advocated reindustrialization by technological innovation. They investigate, discuss and emphasize the importance of policies for technological innovation. In their description of the process of technological innovation in firms, little attention is paid to "the creation of an environment within the firm in which entrepreneurship can flourish and innovations occur (p. 78)." They refer briefly to older studies in which participative and informal leadership, interdisciplinary teams and information flows downwards as well as upwards appeared to be among the factors determining success in innovation (pp. 75 – 79). The concept of 'social innovation' was used to describe "the provision of services outside

53 Frank Pot (sociologist) is emeritus professor of Social Innovation of Work and Employment, Radboud University Nijmegen and chair of the advisory board of the European Workplace Innovation Network of the European Commission. He was director of the institute TNO Work and Employment and had a special appointment as professor of Work and Technology at Leiden University in the 1990s.

the formal economy (in the home)" (p.1). In the same period Bolwijn et al. (1986) emphasized that flexible manufacturing would imply the integration of technological and social innovation. Their concept of social innovation covers all non-technical innovation directed at the competition factors quality, flexibility and innovation capacity among which work organization and human resource management. For these authors, the main characteristics of the innovative firm are participation and democratization. The theoretical foundation of such an approach was provided by De Sitter in his sociotechnical systems design theory (De Sitter, 1981; De Sitter et al., 1996; Mohr and Van Amelsvoort, 2016). Researchers and consultants were responsible for the development and dissemination of these ideas. Policies would follow to some extent but later.

Industrial renaissance in the 2010s

In the 2010s Europe had to recover from the financial and economic crises. Again, industrial policy was at the fore front and again the focus was on technological innovation. However more or less from the beginning of this recovery, formal policy attention was paid to 'workplace innovation'. This concept replaced 'social innovation (of work and employment)' because 'social innovation' had become applicable to all spheres of life and society. Workplace innovation and innovative workplaces were recommended in an Opinion of the European Economic and Social Committee (EESC, 2011). The European Commission (DG Enterprise and Industry) adopted workplace innovation as part of its industrial and innovation policy in October 2012 and launched the European Workplace Innovation Network. It was also used by the European Parliament (2013: 24) and IndustriAll European Trade Union (2014: 8, 9, 15) in their programmes for an industrial renaissance as well as in national initiatives in Ireland and the UK and in the translations of national programmes in Finland, Netherlands, Germany, Flanders/Belgium and Basque Country/Spain (Alasoini et al., 2017).

Definition and measurements

The European Workplace Innovation Network (EUWIN), which started in 2013, describes workplace innovation as follows: "Workplace innovations designate new and combined interventions in work organization, human resource management, labour relations and supportive technologies. It is important to recognize both process and outcomes. The term workplace innovation describes the participatory and inclusive nature of innovations that embed workplace practices grounded in continuing reflection, learning and improvements in the way in which organizations manage their employees, organize work and deploy technologies. It champions workplace cultures and processes in which productive reflection is a part of everyday working life. It builds bridges between the strategic knowledge of the leadership, the professional and tacit knowledge of frontline employees and the organizational design knowledge of experts. It seeks to engage all stakeholders in dialogue in which the force of the better argument prevails. It works towards 'win-win' outcomes in which a creative convergence (rather than a trade-off) is forged between enhanced organizational performance and enhanced quality of working life" (Dhondt, 2012: 2). TNO Work and Employment was commissioned to coordinate EUWIN. More or less familiar concepts are innovative workplaces, high performance/involvement workplaces, employee-driven innovation (Norway and Denmark), non-technical innovation, organizational innovation.

The measurement of innovations in the EU is based on a commonly agreed definition in the Oslo Manual of 2005, implemented by the Community Innovation Survey (CIS), including non-technical aspects as service innovations (new or significantly improved services) and organizational and marketing innovations (new or significantly improved knowledge management systems, organization of work, relations with other firms/institutions, design or packaging, sales or distribution methods).

On 16-17 October 2007, the Six Countries Programme organized a workshop 'Non-technical Innovations - Definition, Measurement & Policy implications' in Karlsruhe to discuss conceptual and measurement issues. Despite the interesting contributions, the researchers and policy makers had to admit that a lot of work (conceptually, methodologically and politically) still had to be done. But at the same time the support for integrating technological and organizational innovation had grown because results of the European Manufacturing Survey – presented in the workshop - showed that Organizational Process Innovation only had positive main effects as well as only positive alignment effects in combination with Process Technology Innovation. Technological process innovation, product innovation and innovation of product related services as well as other combinations showed a worse score (Ligthart et al., 2007).

An important contribution to the debate on measurement, indicators and policy came from Armbruster et al. (2008). They describe and compare how organizational innovations have been measured through existing surveys in Europe. Using the German Manufacturing Survey (1450 companies) in 2003, they show how these different approaches lead to significantly different results regarding the organizational innovativeness of companies within one and the same sample. The authors conclude on four main implications for measuring organizational innovation in more detail than what was common practice in the surveys of that time:

6. Complexity of organizational innovation
7. Life-cycle of organizational innovation
8. Extent of use of organizational innovations
9. Quality of organizational innovation.

Later attempts to add more and better indicators on non-technical innovations to the CIS have not been successful either. The latest try is reflected in the report of Kesselring et al. (2014), based on a seminar with experts.

The struggle is not only conceptual, but political as well. Policy makers did not succeed in admitting the proposed measurements to the CIS.

A kind of indirect measurement can be found in the European Working Conditions Survey of Eurofound, in particular the indicators for the cognitive dimension of work, decision latitude and organizational participation which are supposed to contribute to innovative work behaviour (Eurofound, 2016:80). The same holds for organizational participation as measured in the European Company Survey and the case studies based on this survey (Oeij et al., 2015).

Where does workplace innovation come from?

How can this emergence of interest in workplace innovation, this new élan, be understood? The broader context is that in the early 1990s a significant shift in Europe's economy and businesses could be observed fuelled by information technology. This shift reversed the historical pattern where tangible capital was considered to be the main asset in companies. Around 1990 investments in intangible capital (in percentage of adjusted GNP), such as patents, R&D, marketing, organizational competences became higher than investments in tangible capital (Corrado and Hulten, 2010). Regarding innovation, the conviction grew in Europa that 'social innovation' (work organization, competence development, employee participation, etc.) is probably more important than 'technological innovation' to explain the company's performance. DG Research and DG Employment facilitated a number of networks and research projects on innovative work organization (Pot et al., 2016) such as the European Work & Technology Consortium (1998) and the European Work Organization Network (EWON, Totterdill, 2002). Business models changed from products (Philips: light bulbs) to services (Philips: city lighting). This context explains the need to develop and utilize the skills and competences of the present and potential workforce to increase added value as part of a competitive and

knowledge-based global economy (European Commission, 2014). One more reason for 'workplace innovation' is that private and public organizations can only fully benefit from technological innovation if it is embedded in workplace innovation (making technology work by means of proper organization). Finally, there is a need to enhance labour productivity to maintain our level of welfare and social security in the near future with fewer people in the workforce due to the ageing population.

The proportional shift from tangible to intangible investments meant a lot for styles of management. As 'hard' technological innovations do not seem to explain persistent productivity differentials, Bloom and Van Reenen (2010) present evidence on another possible explanation for persistent differences in productivity at the firm and the national level – namely, that such differences largely reflect variations in management practices. They stand in the tradition of the *resource-based view of the organization* as the framework of research into the conditions for acquiring and maintaining competitive advantage. The focus is not only on the competitiveness of products and services but on internal resources for competitive advantage as well, such as management skills, work organization, knowledge and competences. Competitive advantage can be achieved when these resources improve efficiency and efficacy and when they are rare or difficult to copy. The *dynamic resource-based view* of today, taking into account necessary adaptations to changes in the environment is directed at *dynamic capabilities* (Eisenhardt and Martin, 2000). The OECD calls it 'knowledge-based capital' (KBC) (OECD, 2012) and fosters innovative workplaces (OECD, 2010a and 2010b). So, this is not only about management capabilities but about innovation capacity on organizational level as well. One of these management capabilities is 'managing human resources', how to stimulate 'employee voice' or develop 'employee capabilities'.

According to DG GROW, workplace innovation improves motivation and working conditions for employees, which leads to increased labour productivity, innovation capacity, market resilience, and overall business

competitiveness. All enterprises, no matter their size, can benefit from workplace innovation. It improves performance and working lives, and encourages creativity of employees through positive organizational changes, combines leadership with hands-on, practical knowledge of frontline employees and engages all stakeholders in the process of change. The main objectives of the DG GROW initiative are to foster the uptake of workplace innovation across European businesses and raise policy maker awareness, at all levels, of the benefits of these innovations.[54] This policy is also part of the '*Advanced Manufacturing Programme*': (ADMA). It is said that "Workplace innovation has to provide advanced solutions for manufacturing industry, based on the newest technologies. Virtual reality and side laboratories, where employees can perform extra research and experimentation, not connected with their daily tasks, are examples of combining advanced manufacturing technologies and advanced workplaces. Furthermore, workplace innovation can help companies to enhance competitiveness by using the innovativeness and creativity of all employees. (...) The Commission has included workplace innovation aspects in the R&D&I programs for advanced manufacturing. Explicitly including R&D on human-centred manufacturing could enhance the active and innovative role of people in factories and could contribute to design the workplaces of the future" (European Commission, 2014: 27 - 28).

In 2015, DG EMPL published '*Employment and social developments in Europe 2014*'. Chapter 3 is about "the future of work in Europe: job quality and work organization for a smart, sustainable and inclusive growth". One of the paragraph titles is "Complementing technological innovation with workplace innovation" (p. 164). Presenting much empirical evidence – among which are Eurofound's European Working Conditions Surveys – its conclusion is that better jobs and work organization yield a more productive workforce. Having better jobs and work organization reduces the risk of stress, enhances wellbeing and leads to a lower tendency to quit

54 http://ec.europa.eu/growth/industry/innovation/policy/workplace/index_en.htm

the job. Better work organization implies in particular a balance between job demands (job intensity) and job control (job autonomy), wholeness of tasks and more open access to decision-making processes. This helps to maintain good physical and mental health, while at the same time improving productivity and innovation capacity. These are a few of the indicators which, the report suggests, should inform EU policy making.

Policies of work organization and workplace innovation have never resulted into legislation or regulations on EU-level. Mentioning the issues in Employment Guidelines did not seem to help much nor did national legislation in a few countries. Probably workplace innovation is not suitable for a legislative approach. Implementation depends very much on the social dialogue at European, national, sectoral and organization level. But EU- and national-authorities can stimulate that dialogue and develop campaigns for knowledge dissemination and capacity building. Some of them do, but unfortunately only for a short period of time. Germany and Finland are the exceptions with programs that have been renewed several times over the past decades.

Digitalization and robotization

Germany has the longest tradition of accompanying technological innovation programmes with humanization of work programmes. In recent years the awareness has grown that sociotechnical work organization and job design can contribute to innovation. The present 'high tech programmes' go together with 'future of work programmes'. Finland has been running 'workplace development programmes' for about 20 years now (Alasoini, 2016). The current one is called: 'Business, productivity and joy at work' (2012 – 2018). Belgium started the 'Flanders Synergy' programme on workplace innovation in 2009. The Netherlands had a national programme from 2006 to 2012. Workplace innovation seems to be the adequate 'tool' to benefit most of the newest technologies and to make sure that quality jobs are being maintained and developed.

Many public and private organizations have experienced automation disasters. A major shortcoming was that digitalization and automation were implemented before optimizing processes and work organization. End users were not involved sufficiently. In their book 'The second machine age' Brynjolfsson and McAfee (2014) of MIT observe that in big companies with big ICT projects it takes five to seven years before the organization has been redesigned and consequently before full benefits can be taken from the new technology. They say that "Creativity and organizational redesign is crucial to investments in digital technologies" (p.138). Their concept is 'co-invention of organization and technology'. This co-invention requires the creativity and collaboration on the part of the entrepreneurs, managers and workers.

In my own words: There can be no effective and sustainable returns on automation and digitalization without workplace innovation. I hope and expect that Walter would say: "Yes, I agree".

References

Alasoini, T. (2016). Workplace development programmes as institutional entrepreneurs. Why they produce change and why they do not. Aalto University (doctoral dissertations 12/2016).

Alasoini, T., Ramstad, E. and Totterdill, P. (2017). National and regional policies to promote and sustain workplace innovation, in: Oeij, P.R.A., Rus, D. and Pot, F.D. (Eds.) Workplace Innovation: Theory, Research and Practice (pp. 27 – 44), Cham: Springer.

Armbruster, H., Bikfalvi, A., Kinkel, S. and Lay, G. (2008). Organizational innovation: The challenge of measuring non-technical innovation in large-scale surveys, Technovation, 28, 644–657

Bloom, N. and Van Reenen, J. (2010). Why do management practices differ across firms and countries?, *Journal of Economic Perspectives* 24(1), 203–224.

Bolwijn, P.T., van Breukelen, Q.H., Brinkman, S. and Kumpe, T. (1986). *Flexible Manufacturing: Integrating Technological and Social Innovation*, Amsterdam: Elsevier.

Brynjolfsson, E. and McAfee, A. (2014). *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, New York/London: W.W. Norton.

Corrado, C. and Hulten, C. (2010). How do you measure a technological revolution?, *American Economic Review*, 100(5), 99–104.

De Sitter, L.U. (1981). *Op weg naar nieuwe fabrieken en kantoren (Translated: Heading for New Factories and Offices*), Deventer: Kluwer.

De Sitter, L.U., den Hertog, J.F. and Dankbaar, B. (1997). From complex organizations with simple jobs to simple organizations with complex jobs, *Human Relations*, 50(5), 497–534.

Dhondt, S. (ed.) (2012). *European learning network for workplace innovation*, Section 4 technical proposal, call for tender no 212/pp/ent/cip/12/c/n02c04. Hoofddorp: TNO.

EESC (2011). *Opinion of the European Economic and Social Committee on Innovative Work Places as a Source of Productivity and Quality Jobs.* [online] http://www.eesc.europa.eu/resources/docs/ces543-2011_ac_en.doc. Accessed on 3 April 2017.

Eisenhardt, K.M. and Martin, J.A. (2000). Dynamic capabilities: what are they?, *Strategic Management Journal*, 21 (10-11), 1105–1121.

Eurofound (2016). *6th European Working Conditions Survey. Overview Report*. Dublin: Eurofound.

European Commission (2014). *Advancing Manufacturing – Advancing Europe – Report of the Task Force on Advanced Manufacturing for Clean Production*, SWD(2014) 120 final, Commission staff working document, Brussels.

European Commission (2015). *Employment and social developments in Europe 2014*, Brussels: European Commission.

European Parliament (2013). *Report on Reindustrializing Europe to Promote Competitiveness and Sustainability*, 2013/2006(INI).

European Work & Technology Consortium (1998). *A Medium Term Plan for Collaborative Action*, Nottingham: Centre for Work & Technology.

IndustriAll European Trade Union (2014). *Manifesto to Put Industry Back to Work*, Brussels.

Kesselring, A., Blasy, C. and Scoppetta, A. (2014). *Workplace Innovation: Concepts andIndicators*, Brussels: European Commission.

Ligthart, P.E.M., Dankbaar, B. and Vaessen, P. (2007). *Effective Alignment of Innovation. European Manufacturing Survey 2006/7* (Presentation at six countries programme workshop Non-technical Innovations - Definition, Measurement & Policy Implications, Karlsruhe, 16-17 October 2007).

http://6cp.net/downloads/3_Ligthart.pdf (accessed 3 April 2017)

Mohr, B. J. and Van Amelsvoort, P. (Eds.) (2016). Co-Creating Humane and Innovative Organizations. Evolutions in the Practice of Socio-Technical System Design. Global STS-D Network Press, ISBN-13: 978-0692510032.

OECD (2010a). *The OECD Innovation Strategy: Getting a Head Start on Tomorrow*, Paris: OECD.

OECD (2010b). *Innovative Workplaces: Making Better Use of Skills Within Organizations*, Paris: OECD.

OECD (2012). *New Sources of Growth, Knowledge-Based Capital Driving Investment and Productivity in the 21st Century*, Paris: OECD.

Oeij, P., Žiauberytė-Jakštienė, R., Dhondt, S., Corral, A., Totterdill, P. and Preenen, P. (2015). *Workplace Innovation in European Companies*, Dublin: Eurofound.

Pot, F., Totterdill, P., Dhondt, S. (2016). Workplace innovation: European policy and theoretical foundation. *World Review of Entrepreneurship, Management and Sustainable Development*, 12 (1), 13-32.

Rothwell, R. and Zegveld, W. (1985). *Reindustrialization and technology*. Harlow, Essex: Longman Group Limited.

Totterdill, P. (2002). *Developing new forms of work organisation: the role of the main actors*. Nottingham: The Work Institute (UKWON Working Paper Number 8).

For a new wave of technology assessment

Jos Leijten[55]

Introduction

"Technology Assessment has been defined as a form of policy research that examines short- and long-term consequences (for example, societal, economic, ethical, legal) of the application of technology. The goal of technology assessment was said to be to provide policy makers with information on policy alternatives" (Banta, 2009). In the early days of technology assessment (1960-1970) it had a focus on "big science and technology": nuclear energy, arctic oil, large infrastructure projects in water and transport, etc. Somewhat later industrial technologies and ICT also started to receive attention in TA. They were treated in the perspective of post-war growth: leading to serious changes at different levels (jobs, workplace, organisations, competitiveness of nations) but generally in an environment of increasing wealth and productivity, and growing job opportunities.

The US Congress Office of Technology Assessment was established in 1972. Congress stopped funding the OTA in 1995 in a wave of lean government initiatives. But many European technology assessment initiatives managed to survive the wave of neo-liberalism. The European Parliamentary

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Technology Assessment (EPTA) network has currently 13 full members and about half as many associated members (http://www.eptanetwork.org/).

Walter Zegveld was a strong supporter of the work in the field of technology assessment which started in TNO near the end of the 1970's. He understood the importance of developing a deeper understanding of the societal consequences[56] of new technologies. It was important for politics and policy making to be able to take the right measures to foster specific strategic technologies. And it was important to create a regulatory environment which took care of both positive and negative societal consequences.

The politics of technological change

Technology assessment thus was seen as core to the political process around new technologies. Introducing technology assessment into the politics of technology was in many cases synonymous to establishing a parliamentary technology assessment organisation, either as part of the parliamentary organisation itself or with a clear mission to support the parliament. The premise was that parliaments need to be better informed about the societal consequences of new technologies to be able to fulfil their task of controlling the government. The "big technologies" of the post-war period (nuclear, space, infrastructure, military, etc.) were mostly government led. The societal (and in particular also environmental) consequences of these technologies were often the subject of intense political debate, in which the government - as the official promotor - was partisan. In the 1980's most developed countries also started to foster the sciences and technologies which were seen as the basis for future industrial applications and markets: ICT, biotechnology and new materials (including nanotechnology). Uncertainties about potential future societal consequences of these fields were even bigger.

56 In the following, the term "societal consequences" will be used as shorthand for the range of social, economic, environmental, cultural, ethical and legal consequences.

There is not one specific way in which technology assessments have been done or should be done. But the early days of the US Congress OTA had a few strikingly dominant characteristics: a strong analytic approach to present a well-balanced non-partisan picture to politicians and a considerable and systematic effort to present the findings in a format which suits political practices. The first showed in how the topic of a specific project was decided upon (Coates, 1974), how the research team and advisory group was assembled and high analytical standards. The second showed in a well-established procedure to summarise results in different formats, including a one-pager.

Generally, the European initiatives which followed some 10 years later, took a slightly different approach with their shift of focus from presenting policy alternatives to feeding the societal debate. In 1974 Coates wrote "... technology assessment is a policy generation and analysis or decision oriented tool." Coates 1974). In 1991, we wrote "Technology assessment is a process consisting of analyses of technological developments and their consequences, *plus the discussions in response to those analyses*." (Smits, Leyten, 1991). The shift of focus answered to the need to embed the new increasingly complex and systemic technologies as best as possible in society. And that this required a very broad stakeholder involvement. Societal developments reinforced this need. In its 1978 report "Technology on trial" the OECD specifically refers to the increased assertiveness of citizens and to the growing fragmentation of society, which make it more difficult to reach widely accepted policy goals (OECD, 1978). So, just as in other societal fields, public participation became important for technology policy. It shaped technology assessment and the organisations responsible for it and took them away from a focus on providing policy alternatives.

This move was, for instance, very clearly visible in the Netherlands Rathenau Instituut[57] and similar approaches took precedence in Flanders and

57 "The Rathenau Instituut stimulates public and political opinion forming on social aspects of science and technology". (rathenau.nl)

Denmark. In other countries, however, the link with the parliamentary decision-making process remained stronger, not in the least through the ways in which parliamentarians were involved in the agenda setting of the TA-organisation. This is, for example, the case in Germany (Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag – TAB), the UK (Parliamentary Office of Science and Technology - POST) and with the TA-organization of the European Parliament (STOA). All these TA-organizations took shape in the 1980's and 1990's. But at the same time technology policy slowly disappeared from the political agenda and was replaced by the much broader and more generic concept of innovation policy with a focus on R&D investments, collaboration and networking, entrepreneurship, skills and training, etc. The aim of innovation policy is to increase technological and organisational opportunities as drivers for (economic) growth and the development of new ways of value creation (this may also include social and cultural values).

This change started already during the first major crisis after the Second World War around 1980. It came at a time when many Western countries rather suddenly faced an enormous loss of traditional industries and related labour places in coal mining, shipbuilding, textiles, and the like. Technology Assessment was not really up to the task of helping to find alternatives for these developments. During the 1980's new concepts such as comprehensive technology policy (Smits, Leyten, 1991) and constructive technology assessment (Schot, Rip, 1997) were developed. The core of these concepts was to move technology assessment forward and give it a more active role in the societal shaping of new technologies. In other words, technology assessment should not only make an analysis of the societal impact of new technologies, but it must actively contribute to the search process.

But soon these concepts became more or less obsolete, because in the second half of the 1980's *innovation* had become the keyword. Policies oriented at saving or protecting old industries had by and large failed and

were generally seen as the wrong approach. Public policies at the time were not capable of stopping the massive move of industrial production to Asia. Moreover, industry did not really allow governments to select the technologies of the future and governments were not equipped to do so anyway. Neo-liberal policies became dominant. The Thatcherite transformation of the UK from an old industry dominated country – with all the social structures that belonged to the period – to a modern service oriented society was a success, at least in the eyes of those on the right side of the political spectrum. Painful yes, also in the longer run, but still a transformation to a new and competitive economic structure. In continental European countries, the process was only slightly less painful but the costs of compensating measures in the transformation were high.

On hindsight, I think that the shift of policy attention away from technology toward innovation has had two major consequences for the fields of technology studies and technology assessment:

1. The first change concerns the research about the societal consequences of technological developments. Such research (and the related activities) required an interdisciplinary approach. It needed to combine inputs from many different disciplines to build a comprehensive story around a specific technology, its societal consequences and policy alternatives. With the shift of the policy focus to innovation the research focus also changed. The generically defined process of innovation lends itself easily to be approached from a wide range of different academic disciplines. Economics, public administration, sociology, geography, management sciences, and many other disciplines all have developed their own approaches toward innovation. With the growth of disciplinary approaches in academia came dedicated journals and research groups. Academia became less and less interested in interdisciplinary approaches. It mainly survived in applied research (including the dedicated technology assessment organisations), consultancy and a very limited number of academic centres that recognised the need for

an interdisciplinary approach. From the perspective of technology assessment and for thinking about policy alternatives, the consequence of this fragmentation of research and, more generally, of knowledge, was a loss of useful insights. In depth analysis of the societal impact of technology has become increasingly rare.

2. With the research and policy focus on innovation, the policy debate increasingly centred around generic policy issues such as size and growth of public and private R&D investments, systemic strengthening through collaboration and networking, entrepreneurship and start-up companies, creativity, skills and training, etc. Politics increasingly was focused on growth through innovation. That innovation also means new products, processes and ways of organising, and thus displacement of existing products, products and processes got lost in the generic innovation politics. Nevertheless, certain technologies still led to political debate and reached political agendas, in particular those that involved major ethical concerns, privacy and security issues. One would also expect technologies with potentially major labour market or environmental implications to climb high on the political agendas. For some reason, however, most of these debates remain rather general. Potential impacts are signalled but there is a lack of deeper insights in the characteristics and dynamics of the technologies. Thus, we happily invest in wind-energy and in electrical cars, knowing that these technologies have their limitations. And we know that a new wave of automation with Artificial Intelligence and robotics will again deeply change labour markets, but without really starting to prepare for this change. Political debates often die out with reciting arguments pro and con the use of a specific technology. No policy action follows.

In other words, with the change toward the systemic innovation and innovation policy perspective we have lost something: interest and insight into the complexity of the potential societal consequences of new technologies and the ways in which we can steer these impacts with targeted policies.

A new need for technology assessment

Technology assessment requires a deep understanding of the dynamics of science and technology, of the potential usage of the new technologies and - in the case of tradeable technology products (e.g. computers, medical devices, aircraft, etc.) - of their markets (innovation), and, maybe most important of all, of the interests and strategies of the actors involved. This understanding is a prerequisite for understanding the future societal consequences and even more for contributing to the search process and the societal shaping of new technologies. But precisely this combination of different approaches to the phenomenon of technological change has – for the reasons given above - gone lost in many of today's technology assessment activities.

But this is not intended to be a criticism of technology assessment as it is done today. And certainly not of the existing parliamentary TA organisations. We must be happy that they exist. In the first place, they are one of the few places where a debate about technological developments and the ways in which they have impacts on society can take place. Even if such a debate does not provide answers for policymakers, at the very least it shows which are the contested issues, which questions to ask. And in the second place, they are well positioned to provide the knowledge which politicians need when nations move away from the generic neo-liberalist policies to more targeted policies. And this is precisely what we see happening now, for many different reasons. There is the popularity of the argument for an active and selective role of politics made by Mariana Mazzucato in her "The entrepreneurial state" (Mazzucato, 2013), the growing talk about challenge, mission or moon-shot driven research and innovation policies in Europe and, not to forget, the growing (populist) tendency to focus policies on fostering national interests and national champions in research and innovation.

In view of such developments the need for knowledge which helps the development of such politics will grow.[58] And the problem has not become easier since the early 1970's. Over the years, technologies generally have become much more complex, because they are usually composed of a set of very different technologies and are more versatile in their applications compared to the "big technologies" which started the development of TA. The use of ICTs even has become ubiquitous, pervading all sectors of society. Also, technology has become a global phenomenon with global interdependencies, globally interconnected applications and global technology platforms. But, with globalisation under political pressure, it becomes increasingly important to understand the interdependencies and the vulnerabilities that come with them.

Technologies which urgently deserve attention

I now would like to illustrate the (new) need for technology assessment with a couple of cases (technologies) which urgently deserve attention in analysis and in politics.

The European Commission and several Member State governments are seeking ways to keep some of the earnings the likes of Google, Amazon and AirBNB are making in Europe, either by way of imposing penalties for alleged violation of antitrust laws and other excessive market power behaviour, or by way of introducing new rules for taxation. In other words, Europe has a problem with strong internet platforms, of which most are US based, but the US-based companies may soon be joined by Chinese competitors (with Alibaba as a frontrunner). Much has been written about so the called "winner takes all" platforms, both on the level of the appliances and their operating systems, with Apple, Google and Microsoft as prime examples, and at the level of networked applications.

58 Here I take the optimistic stance that the present tendencies towards uninformed power-politics will not live very long.

AirBnB and Homeaway are both operating in the same market of private holiday accommodations. After large numbers of take-overs and about 10 years (somewhat less for AirBnB) of clever marketing strategy together they now have about 30% of this market, with Homeaway leading. Starting in 2005 Homeaway took over more than 20 national and regional online market places (e.g. FEWO.de and realholidays.com.au). Although their markets now largely overlap, AirBnB had a slightly different start with its online offering of home-stays. And still, looking at the more than 15 take-overs since 2011, the strategy of AirBnB looks slightly different, because it includes companies that offer additional touristic information, restaurants and other info that adds value to a booking. And the takeovers also include technology oriented companies, to expand the possibilities of the booking platform (e.g. Trooly, which provides trust platforms, or DECO, a mobile app builder).[59] Further consolidation and thus larger market shares for the main players are underway. In 2016 Expedia and Booking, so far mainly operating in professional markets, announced that they will enter the private accommodations market. Expedia took over Homeaway in 2015, and Booking has been building up a large offering of its own over the past 5 years.

This example is just one of many which can be given to illustrate how the power of network externalities is steering the development of internet platforms. It is not just that the platform companies earn something between 10 and 20% on each booking. They also transform markets and market behaviour of consumers and suppliers profoundly, with profound societal consequences. AirBnB has been hailed as a champion of the so-called sharing economy, but is now seen as a major responsible for cluttering the inner cities of Barcelona, Amsterdam, New York, etc. with tourists

59 See for example: https://www.emerce.nl/nieuws/expedia-booking-gaan-airbnb-verslaan en http://www.vrmintel.com/airbnb-vs-homeaway-winning-race-top-vacation-rental-industry/. More details on the takeovers and respective companies can be found on crunchbase.com.

and disrupting local housing markets. Governments basically do not know how to deal with the changes, negative of positive. Local governments set limits on people that want to offer their home on AirBnB and need to build a complex system of control, instead of forcing AirBnB to maintain these limits, as is done in the USA. This is where good old-fashioned technology assessment could have helped. It would systematically have identified the different interests of the parties involved, of potential future developments in view of the power of network externalities, and the societal tensions they may lead to. And it would have identified policy alternatives. Of course, quite a lot of research and assessment work has been done, including by several of the parliamentary TA organisations in Europe. But none of this work has been visible and powerful enough to show politicians that in the case of the online broker platforms, the suppliers and consumers can benefit from guidance and from knowing where boundaries are. Even a sort of stepwise process on how to (politically) deal with the many uncertainties in these developments helps.

Similar arguments can be made about other technology driven developments. The field of ICT is providing many examples. In the case of Artificial Intelligence, robotics and Internet of Things, the question arises how to prepare workers and labour markets for the changes which are going to come. Some have proposed the basic income for all as a solution for employment losses, of which we are not even sure they will come. But if it leads to mass unemployment, we will also need to discuss much more general questions such as: Who owns the work of robots?[60] Blockchain (the

60 "even if we take the "industry 4.0" transformation as real, we cannot help the congregation of many heretical questions on our desk: given the transformation of the technological order based on robotics, to whom will the ownership rights of the robots belong? States as owners of public (-?) capital? Private ownership as organized along trans-national corporations under the post-imperialist phase of global capital? Men and women of the scientific community who in the first place designed and projected them? Or perhaps, a de-centralized, democratically operating societal network, above and beyond nation states?" (Yeldan, 2017)

technology behind Bitcoin) has been welcomed as a decentralised trust infrastructure for all kinds of transactions, but the experiences with Bitcoin itself (hype, high volatility, theft) and the attempts to "privatise" this technology for dedicated user groups urgently deserve deeper analysis. At the very least by bringing all experiences and existing analyses together and turn these into a good analysis for politics.

One of the most exciting technological developments of the near future will be the integration or convergence of digital technologies and living systems biology. Examples of such integration are many, including implants, bio-computing, lab-on-a-chip. and direct brain-computer interaction. So far progress is slow but it is persistent. It will have many societal consequences, most likely in all fields of society, and it will raise ethical and legal questions. Again, the question of ownership will become very prominent.

Developments need to be carefully followed and analysed. And, when needed, politics should be prepared for action with a set of policy alternatives. It requires insights in the technology trends, in when certain barriers can and will be taken, in the strategies of the players, an in how it might change behaviour of people and systems. Will the same platform characteristics and network externalities as discussed above come to drive the development of applications and markets?

Somewhat closer to today are the developments in the field of energy. Apart from the growth of (the number of) renewable energy sources, we also witness an enormous growth of diversity in applications. The use of LEDs provides many good examples of new applications and design solutions. At the same time, politics has made a choice to invest mainly in wind and solar, combined with reduction of energy use in homes, offices and transport. But politics also needs to be prepared to change strategies in view of the rapid technology developments. Or probably even better, to invest more in increasing the range of technological opportunities. To be able to do this, an analysis is needed, mapping both the divergence of techno-

logical developments and opportunities, and the interests and strategies of the different players. There is probably no technology field where so many studies are available, but at the same time it is very difficult to distil a good overview of opportunities and the related policy alternatives.

A new politics of technology assessment

Making TA useful for politics requires bringing together technology experts from the different fields of relevance which together can handle the complex dynamics of how the technologies and ensuing innovations may develop. It also requires analysts with a broad background in technology studies[61] who can recognise patterns and systemic interactions in the development of the technologies. Very often these are overlooked by the technologists themselves, with their focus on making things work. Next come in the people who understand the potential usage (and/or markets) of new technologies, and the impact on economy, society, culture, environment, etc. And TA needs people who know how to translate the findings to politics, to policy alternatives and the legal system. It puts a high demand on the people involved to collaborate on many different levels and issues. And it puts a demand on resources. Although, over time and in different institutional settings the topics that need to be analysed and discussed in many cases are likely to get sufficient attention. Some in academic studies, some in government commissioned research and/or consultancy reports, some by NGO's, or industry think-tanks and some by the parliamentary technology assessment organisations. The results, however, are frequently biased by the context in which the analysis is performed, they are fragmented and hardly easily and freely accessible. Reinforced technology assessment initiatives thus may not only deliver efficiency gains, but, more importantly, they must bring together fragmented insights and help to

61 In academia, this field of study is usually called Science and Technology Studies or short STS.

identify policy needs and alternatives in ways which take good account of the different interests involved.

The key question now is why technology assessment has not reached the status and influence which it needs to have. We can think of several reasons, which partly have to do with the ambition of the TA-community to deliver neutral and unbiased advice on sometimes highly contested issues, which are a reason for most, if not all, stakeholders (within and outside government) to have a preference for doing their own analyses. This in not really helped by a focus on organising public debates around such contested issues, because debate is certainly a thing which stakeholders want to control themselves. But the main reason must probably be in the fact that politicians, for reasons already discussed above, have forgotten to table the hard questions about technological developments in inquisitive ways. It is about time that they realise that most technology is generated with public money, not just in fundamental research, but also in very close to market demonstrations and pilots. Some of these technologies have become systemic, in the sense that whole communities (clusters, hubs) have become dependent on them. A feeling of "public ownership" and the development of the necessary practices for this, would be more than justified.

In any case. we, politicians and people, need to be better prepared for what technology makes possible and for the changes related to this. In the end, this is probably what knowledge society is all about. The state of politics nowadays makes a direct political initiative to strengthen and broaden the role of existing TA-initiatives illusionary. But there will probably be very little resistance if the science, technology and innovation research units of universities and research organisations start to coordinate and pool their resources at national and international levels. The existing parliamentary TA organisations might play a light stimulating role by bringing the key people for different topics together, not for asking their opinions

(which is what they do now) but for developing a strong joint research agenda. If such an agenda is voluntarily agreed upon, it does not need the explicit approval of parliaments. The European Parliament might also play a supportive role, by carrying its interest in so-called Responsible Research and Innovation beyond the level of individual projects to the higher level of systemic societal changes. The resulting works will in due time and with gaining mass help to make people and politicians better prepared to deal with the ever-increasing wealth of technological opportunities.

References

Banta, D. (2009) „What is technology assessment?," International Journal of Technology Assessment in Health Care, nr. 25 Supplement 1, pp. 7-9, July 2.

Coates, J. (1974) „The identification and selection of candidates and priorities for technology assessment," Technology Assessment, vol. 2, nr. 2, pp. 77-104.

Mazzucato, M. (2013) The Entrepreneurial State, Debunking public vs. private sector myths, Anthem.

OECD (1978) „Technology on trial," Paris.

Schot, J. en A. Rip (1997) „The Past and Future of Constructive technology Assessment," Technological Forecasting and Social Change, vol. 54, nr. 2-3, pp. 251-268.

Smits R. and J. Leyten (1991) Technology assessment, waakhond of speurhond? Naar een integraal technologiebeleid., Zeist, Kerckebosch.

Yeldan E. (2017), „Social Europe," 7 August 2017. [Online]. Available: (https://www.socialeurope.eu/beyond-fantasies-industry-4-0-global-capital-no-answers.

Innovation as learning - learning from innovation

Remarks at the Six Countries Program 40th Anniversary Workshop Vienna 24 – 25 March 2015

Lennart Elg[62]

The background paper[63] has provided an excellent summary of what we have learned over the past 40 years about the nature of innovation and conditions conducive or detrimental to innovations. So I will not go back and reiterate this. Instead, I will argue that we need to develop a new mental model of what innovation is, and what this implies for policy. A model based on our experiences as policy makers and policy analysts.

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62 Lennart Elg is a former chairman of the Six Countries Program. He has worked as a policy analyst for the Swedish innovation agency VINNOVA and its predecessors, NUTEK and STU, and has served as Sweden´s representative in the OECD Working Party on Innovation and Technology Policy, and as an expert to the European Commission.

63 Leijten & Loikkanen, in this volume.

Mainstream economists have led us astray, by equating science with the production of information, and trying to add this "information" as another input into their static production functions. Innovation is seen as a production process whereby codified knowledge is transformed into new products or processes.

However, innovation is also a process of cumulative organizational – and inter-organizational – learning, which changes agents' behaviour over time, as they build new competence. This is of course implied by evolutionary concepts like path dependence, but the consequences are not often spelled out explicitly. I will argue that this is the core process in a longer perspective, and needs to be the focus of innovation policy.

First a few words about my background, as this has no doubt coloured my view on these issues.

For forty years I worked as a policy analyst, and sometime practitioner, in innovation and technology policy. Most of the time I was trying to bridge the gap between policy practice and policy research (in both directions), with a special interest in the relationship between publicly funded research, mostly in universities, and innovation and new technology development in industry. "The role of public research in innovation" was always at the core of my work.

However, I did not enter this field as an economist, or as an engineer. Instead, my background was in cognitive psychology – with a focus on problem solving and group interaction.

Later, I came to approach the concept of innovation systems not as a way to disaggregate the national policy environment, but bottom up. Before the concept of innovation systems entered our vocabulary through the pioneering works of Freeman and Lundvall, a study of industrial innova-

tion at SPRU, Project SAPPHO[64], had emphasized the importance of knowledge flows between users and producers of new innovations. The Uppsala based "network" school had shown that that such user/producer linkages could evolve over long periods of time, in some cases over a century[65]. Erik Dahmén´s concept of development blocks[66] also resonated with Swedish industrialists and policymakers (perhaps more so than with other economists).

Thus I came to see the concept of innovation systems as a set of useful mental models, but there is no such things as the right or wrong model – which model is "right" depends on which formulation is most useful in addressing a specific question. Whether our models should best be formulated at the national, regional or sectoral level is an empirical issue, and you can build different models based on the same set of empirical observations.

My point of departure

From the early years of my career, a recurring issue has been the relationship between corporate innovation and public research, and in particular why companies choose to engage in active collaboration with public sector research, rather than being passive consumers of published research findings. An interaction we are now familiar with as "public/private partnerships".

A couple of studies in particular raised my interest in the motives for companies to participate in collaborative research, and made me question the conventional view that companies are primarily looking for "research results" which they can "commercialize". The first was a set of interviews I

64 Rothwell et al (1974)

65 Håkansson & Snehota (1989)

66 Dahmén (1988)

was involved with, in collaboration with the Royal Swedish Academy of Engineering Sciences, with Swedish corporate R&D managers (and in some cases CEOs) about their motives for participating in EU Framework Programmes. This study also pointed me to a much more ambitious UK investigation of the same issue[67].

A second set of inputs were two Swedish dissertation projects addressing industry/university interaction, by Anders Broström[68] and Eugenia Perez Vico[69] (I was involved in the second project as one of the thesis advisors).

From a policy point of view, a natural follow-up question is why do we need public intervention for such interaction to happen? This was addressed in a synthesis of a number of long term impact studies of R&D programs sponsored by VINNOVA and its predecessor organizations[70].

A DIFFERENT WORLD

The world was a different place in 1975, when the Six Countries Program was founded. Nixon had just resigned as president, Breshnev ruled the Kremlin, and the world was divided between developed and underdeveloped nations, with a clear divide in between. China was in the middle of Mao´s "cultural revolution"

Mankind had been to the moon and left, but handheld calculators were the hottest thing in information technology and the floppy disk was a new invention. Jobs and Wozniak were off in a garage, tinkering with the Apple I, but the world wide web was 15 years away. Genentech would be founded the year after the 6CP.

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67 Office of Science and Technology (2004)

68 Broström (2009)

69 Perez Vico (2013)

70 Elg & Håkansson (2012)

40 years ago, markets were seen as reasonably stable and predictable – industry focus was on how to bring new products to market in an efficient way in order to defend market shares. I am not sure to what extent this more stable envoironment was a real difference, or the result of more nearsighted perception, though. In today´s more competitive environment with rapid product lifecycles where the winner often takes all, making the right bets on where the market is going has become more important than internal efficiency – focus has shifted from HOW to WHAT questions.

Back in 1975 companies still had a national identity, and it made sense to think of innovation policy supporting national flagship companies. In the current world, where footlose companies shop around for the best competence whereever it is located, the role of national policy comes closer to how we have seen regional policy: to make it attractive for companies to locate high value-added activities in a country or region and to anchor existing companies in the local innovation system. Such a systems-based innovation policy can no longer attempt to optimise a more or less complete national system of innovation. Rather, the task for policy is to decide what roles we can aspire to in various globalised innovation systems. This requires specialisation. We must become the best in the world at something instead of being "good enough" at everything.

The need to transition our economies onto a more sustainable development path has added a new dimension to innovation policy. Many of the changes required will be large scale and systemic in nature. The market is the most powerful selection mechanism we know of, but it is myopic: It can only select among alternatives which are already available, and we know from other fields that the market can lock in to technologies which appear superior at the time but which prove less than optimal in a longer term perspective. [71] There is a case for policy to keep longer-term options alive until they can prove themselves, but for how long?

71 See for instance Loorbach (2010)

The increasing share of service production in our economies might lead us to think that technology is becoming less important, but service innovations are often interlinked with products and new technology. As an example, more than 75 % of Ericsson's revenue comes from service contracts – but these are tied to the systems Ericsson has sold.

The nature of innovation – what have we learned?

As innovations and new technology have emerged as the primary driving force of economic development, viewing them as inexplicable "acts of God" gives little guidance to policymakers concerned with the performance of the economy. I will attempt to argue that, taking a closer look, innovation is best viewed as a process over time characterised by searching, experimenting and learning.

We know from case studies that innovation is not a sudden flash of genius, but a long process of searching, experimenting and learning, as Thomas Edison noted in his famous quote: "Invention is 1% inspiration, 99% transpiration". Searching for better ways of doing worthwhile things, experimenting: because we can't see in advance the best way of accomplishing a desired outcome (or indeed what users really want or need), and learning, as actors involved in an innovation process will learn from it, a learning process which will change their ability to tackle future challenges and opportunities.

"Innovation processes may be seen as a process of joint production where one output is innovation and the other a change in the competence of the involved agents"[72]

72 Lundvall, (2005)

New ideas are of course a necessary ingredient, but ideas come to those whose minds have been prepared, and require a lot of further elaboration before they are ready to face the world.

As Nathan Rosenberg has emphasized[73], this elaboration can best be described as a long search process where an initial vauge idea is developed, re-evaluated and reshaped as it faces the various requirements of the real world. A lot of the real value derives from subsequent refinement, based on both new inputs and feedback from early users – an Apple II computer would be of little practical use to us today.

Innovation should also not be understood as a linear progression from research "results" or an "invention" to industrial application. Rather, it should be seen as a messy search process, where organizational (and inter-organizational) learning is at the core, and is the most important long term result as this learning changes participants' ability to face future challenges.

This search process builds on a number of different competences which need to be integrated. Science is one of many inputs into this process, but is often used indirectly, embodied in handbooks, consultants, purchased components etc. Publicly funded research can contribute in many different ways and at all stages of the innovation process. For this to become a reality requires policies that allow for continuous interaction so that researchers and companies can learn from each other.

Bengt-Åke Lundvall discusses two modes of learning which interact with each other in the innovation process: ST (Science & Technology), research & development within or outside the company, and DUI (Doing, Using, Interacting), learning in production, learning from users/customers and learning through interaction with a broader base of knowledge sources .

73 Rosenberg (1982).

Lundvall contrasts S&T learning with on-the-floor learning through "Doing – Using – Interacting" – but S&T-based innovation also depends crucially on doing, using and interacting, albeit over longer distances and timescales.

In order to realize their full potential, major innovations need to combine changes in technology, organizational innovations and new business models. When electric power was first applied in industrial manufacturing a century ago, a large electric engine in a corner of the factory replaced a steam engine, powering a large number of machines through an elaborate system of overhead belts and pulleys. The only possible gains from this was the cost difference between steam power and electric power. It was only when electric motors became small enough that each machine could be fitted with its own power source that the full benefits could be realized, as machines could now be placed to suit the flow of production, rather than being aligned to the overhead belt system[74].

IKEA's success is usually described as based on a business model innovation – selling disassembled furniture in flat packs and persuading customers to do the assembly. But its business model is also supported by large investments in information technology to manage a complex supply chain, and organizational innovation to manage the relations with thousands of suppliers.

Technology is not just "applied science"

Modern technologies are increasingly based on a scientific understanding of the underlying phenomena, but there is nothing simple about the relationship between the two domains.

74 David (1990)

Brian Arthur[75] describes technologies as "means to an end", natural phenomena used in a controlled fashion to achieve a purpose. New technologies never arise out of the blue; they are always new combinations of existing technologies. In that sense technologies are systems which become increasingly complex as we refine the technology to gain better control of it. While science helps us understand the underlying phenomena better, how to integrate these in a system for a specific purpose is the domain of engineering, and cannot be deduced from first principles.

Technology also has its own dynamic, not just waiting for "new research results" to apply. The main driving force is solving problems, not "advacing the frontier": Developing a technology will identify bottlenecks, and searching for solutions to these may involve both previously unrelated technologies and research findings which have been stowed away in "the book of science" for a long time.

Developing a technology also needs to take into account situational awareness about the environment in which it will be applied; not only technical requirements but also human preferences, legal constraints and cost considerations.

Finally, the dependence between technology and science is not one-sided. What can be explored by science is limited by the existing technologies. Or as physiologist Lawrence Joseph Henderson observed almost a century ago: *"Science owes more to the steam engine than the steam engine owes to science."*

75 Arthur (2009)

Complex processes of searching and learning

Another way of describing this is to say that there are several parallel search processes going on: Finding out WHAT to do, HOW to do it, and WHO we need to cooperate with? In retrospect we often focus on the question of "how", and admire an elegant new way of reaching a goal which appears obvious with the benefit of hindsight. But finding the right balance between conflicting requirements is equally important, as innovations are never shaped entirely within the confines of a single organization: finding the right partners is also an important challenge.

- WHAT to do?

  Any innovation is a compromise based on trade-offs between mutually incompatible requirements - and we cannot calculate an optimal trade-off in advance. So in the early stages of a radical innovation we typically have a phase of experimentation, with many, often new companies exploring the market with different configurations, until a "dominant design"[76] emerges. "This is a product design whose main components and underlying core characteristics do not vary from one model to another. The dominant design has features that competitors and innovators must adhere if they hope to command significant market share"[77]. It is often synthetized from individual innovations introduced independently in previous product variations. At this stage, competition changes to providing increasingly sophisticated variants of the dominant design, more R&D is devoted to efficient production and the market becomes dominated by a small number of larger firms.

76 Abernathy & Utterback (1978)

77 Utterback (1994)

- HOW to do it?

  There are usually multiple possible solutions These alternatives are not fully developed so it is hard to predict their potential for refinement, the target is shifting as we learn more about user requirements etc, and market research is of little use for a novel offering which users do not have previous experience with. And there are often network externalities which mean that what is the "best" solution is contingent on how your competitors act.

- WHO to cooperate with?

  Finding out WHO we need to cooperate with, in order to get access to the competences we need, as no single actor can hope to possess all the necessary competencies or information.

All three aspects are complex issues which can only be resolved by trial and error. Success does not come from making the correct initial analysis but from being prepared and willing to learn from experience and being quick to readjust[78]. This phase of experiments, is characterized by genuine uncertainty, i.e. even the structure of the problem is unknown, not just a set of unknown parameters within a well understood problem (I will come back to the issue of genuine uncertainty later).

The period of early experimentation is not only a Darwinian selection mechanism, where the "fittest" companies survive and the rest go under. Other competitors can also observe and learn from experiments by observing them.

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78 Venture capitalists consistently insist that they would rather invest in "an A grade group with a B grade idea" than the other way around: The winner is not the best original business plan, but the team who are best able to adapt and revise..

The role of public research

Policymakers (or their economist advisors) too easily equate "research" with "published research results", but academics can contribute to practice in many other ways, not only linked to their peer-reviewed journal articles but more often based on their accumulated experience, overview of the field, personal networks etc.

Impact studies and other research[79] show that the contribution of research to business development is much broader than initiating new product ideas or new technology-based companies, and that focusing on these risks ignoring the most important roles for public research.

Rather, the main impacts on businesses have been helping them to develop capability in new areas by recruiting staff with relevant research backgrounds; accessing research networks and thus getting an overview of developing new knowledge field, etc. The primary function of government support to industrially relevant public research has been to help develop the innovation system´s capacity for innovation, not subsidising individual innovations.

Incentives for companies to cooperate with universities can be illustrated by the reasons companies give for participating in EU Framework Programmes[80]:

Companies' reasons for cooperating with public research are not only to support existing operations but to a large extent to gain a better basis for strategic decisions as to new areas in which individual companies need to

79 Cf. Jacobsson & Perez (2010), Martin & Tang (2007), Salter et al (2000), Broström (2009), Elg & Håkansson (2012).

80 VINNOVA (2008)

accumulate knowledge – strategic orientation and uncertainty reduction. Active collaboration is also a way to Identify and recruit talent in identifed priority areas and to identify possible collaboration partners. Joint R&D programs can also provide strategic intelligence, a better understanding of how other actors view the future, and act as a platform for strategic action: a forum to influence not only public research agendas but also the choices of other actors in the system: Participating in EU programs is seen as a way to influence future ICT standards in ways which suit the competence profile of a specific actor..

A study of the impact of public research on the development of the mobile telephone industry in Sweden[81] suggests that expertise in radio communications, built up through a series of programmes, was central to Ericsson's ability to rapidly acquire a leading position as a systems supplier. Even so, the study notes that no single product concept was derived from university research.

The trouble with economists

Mainstream economists often think of innovation as a production process, where knowledge is transformed into a new product that takes the world by surprise. We measure R&D investment, relating these to outcomes in the form of patents, new products, GDP growth and so on. Then we congratulate ourselves on high levels of R&D investment, or worry about a European "research paradox".

However, trying to add proxy indicators for knowledge into their production functions is problematic in several ways. Quantitative indicators miss the important aspect of competition which is product differentiation.Such models were built on the production of homogenous raw materials (or

81 VINNOVA VA 2008:04 The GSM Story.

highly standardized products), but as Abernathy and Utterback showed[82], this is only the final decline of a product lifecycle, when competition has deteriorated to being based on price alone.

Secondly, there is no simple relationship between the amount invested in R&D or innovation, and the financial outcome. Investing in innovation is more like buying a lottery ticket: Investing is necessary to participate, but there is no guarantee that you will win, indeed in the globalized knowledge economy an increasing number of markets are characterized by "winner takes all".

The lottery, however, is also a dangerously misleading metaphor. The lottery is a well-defined game where the rules and odds are known, and economists have built their careers around analysing strategies to deal with such games.

However, innovation is a game where the rules are not only unknown but unknowable[83], as the value of your own investment - even if you meet your own goals – will depend on the decisions of a number of other actors who are all playing their own versions of the same game.

A more productive mental model may be to think of innovation as a form of learning – for organisations and on an individual level. Professor Richard Nelson, probably the world's leading expert on innovation from an economic perspective, defines innovation as:

"The processes by which firms master product designs and production processes that are new to them, if not to the world, nation or sector."

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82 Abernathy & Utterback (1978)

83 For discussions about the distinction between "known unknowns" and "unknown unknowns" see Kay (2011) and Taleb (2007)

Note that Nelson's definition focuses on processes whereby companies learn something new, and not on the results; new products or processes.

Innovation as organizational learning

As I have discussed earlier, innovation is not a sudden flash of insight out of the blue, but the result of a long search process. Along the way, would-be innovators have learned what works and what doesn´t, what can be achieved and different routes to this, and they have gained a better understanding about the real needs of prospective users.

From all of this follows that any innovation process has two kinds of results. In the best case, the process gives rise to a new product or service that is successful in the market, but whether it succeeds or not, those involved will have learned things along the way, which will alter both how they view future threats or opportunities, and their capabilities to address them. Such knowledge will affect what can be learned in the future and how new knowledge will be evaluated. (Of particular value is knowledge of what did not work, especially if there is an understanding of why it did not do so this time.)

This is not a new idea. The influential book by Bengt-Åke Lundvall et al which in 1992 introduced the concept of National Systems of Innovation was sub-titled "Towards a theory of innovation and interactive learning"[84]. And in a retrospective article written two decades later, Lundvall notes: *"Innovation processes may be seen as a process of joint production where one output is innovation and the other a change in the competence of the involved agents".* [85]

84 Lundvall (ed., 1992)

85 Lundvall (2005)

But while the concept of national innovation systems has become part of the established dogma of policymakers (although one is sometimes tempted to wonder to what extent the concept has been understood), innovation as interactive learning has gathered far less attention.

New knowledge is not discarded once it has served its immediate use, but is retained both in the memory of individuals and in organizational memory. New informal links have been forged to sources of information both within and outside the organization, and existing linkages have been revaluated.

The issue of whether organizations learn – or only individuals in organizations – is illustrated in a classic study by Henderson & Clark. They note that, through several generations of integrated circuit production, market leaders in one generation failed to maintain their leadership in the next generation, even though the basic technologies remain the same. Their explanation is that although the technologies were stable their relationship changes in subtle ways: What are the critical bottlenecks in the overall configuration, etc. This "architectural knowledge" is largely tacit and is not carried by individual specialists, but through both formal reporting arrangements and informal communications channels: "Who is the guy to talk to when you have a problem of this kind?"

Learning is also a prerequisite for innovation. Ideas do not come as a flash of genius from a clear blue sky. New combinations of existing knowledge require a large toolbox of knowledge elements which can be combined.

Furthermore, as noted earlier innovations are not born fully formed. Interacting with early users is an important part of the innovation process. This process involves learning to better understand the needs of different users and see how an innovation works out in reality.

The major theoretical foundation for studies of innovation is evolutionary economics. A basic tenet is that economic actors by necessity must have limited knowledge of the world and capacity to absorb and process new information, and that these capacities will develop differently as each actor experiences unique challenges. This is of course another way of saying that economic actors learn, but is seldom discussed in such terms.

Such learning processes are at the heart of evolutionary economics, but evolutionary economists have mainly focused on the implications for economic theory, less on how learning takes place.

Innovation policy should create opportunities for collaborative learning

To brings these remarks to a conclusion, I believe that innovation policy would benefit from focusing on the learning aspect of innovation.

In the long run, this is the most important result: A successful new product or service always has a limited lifespan, and is of little long-term value unless the firm has also developed the capability to follow up. This is a lesson we first learned through the failures of early technology transfer programs back in the 1970´s.

New capabilities may also be a more realistic proximate indicator of policy impact. Trying to assess the impacts of innovation policies – whether in order to improve their effectiveness or to persuade sceptical finance ministers - has always suffered from the fact that the further downstream you try to measure in order to capture the full impact, the harder it becomes to attribute these impacts to a specific cause. It might even help us to formulate policies which are adapted to specific circumstances without immediately being accused of “picking winners”.

An innovation oriented S&T policy should be aimed at creating mutual learning opportunities. And this is not a system for linear transfer of knowledge - academic research needs to learn about the problems and problem context of business in order to shape their research agenda, as much as business needs to learn about what academic research has to offer.

This is again not a very original thought. Among others Nathan Rosenberg has made the same argument back in 1992 in his essay "Science and Technology in the Twentieth Century" [86].

The recent decades have seen a shift in public science and technology policy in many countries, away from subsidizing research and development projects in industry, towards promoting public/private partnerships between industry and public research, not least through the European Union's Framework Programs. This can be seen as at least an implicit acceptance of learning opportunities as a policy objective, but a mismatch between rhetoric and practice can limit how far such a shift can be taken.

Need for policy learning

As there are no simple prescriptions for optimal policies, the ability to learn is important also for policy development. This involves both the ability to learn from others, while we take into account differences in policy context, and the ability to learn from our own experiences and take these into account when we develop new policy instruments. Programs differ in terms of the characteristics of the knowledge field, the involved actors, prospective users etc. Policy must take such differences into account, and not try to apply a standard model regardless of the circumstances.

86 In Dosi et al (1992)

A challenge for this more complex understanding of innovation is to educate policymakers, so they understand the need to have a varied portfolio of policy instruments, and the need to be able to experiment. As the effectiveness of a policy measure depends on the specific context in which it is applied, policies must be developed in an evolutionary process of experiment, evaluation and adjustment. This is a hard concept for us to sell, as policymakers too often see the need to adjust and adapt as an admission of failure.

Role of policy research

From the start in 1975, the Six Countries Program has provided a continuous dialogue between social scientists focusing on innovation, and interested policymakers and practitioners.

As policies need to be context dependent, we cannot derive policy recipes directly from policy research. In my own experience, the most valuable contributions from such research has been the introduction of new concepts into the policy debate, new glasses through which we can see the world in a slightly different way.

- In the early 1980´s, new technology-based firms were identified as an increasingly important category, whose needs were very different from what was provided through traditional policies to support small and medium-sized enterprises.

- In the 1990´s the concept of innovation systems – whether national, regional or sectoral – changed the way we think about how innovations develop, about the interdependence between actors and about the role of policy.

The need for active dialogue between practitioners and academic studies is equally strong in the policy arena. Practitioners benefit from being aware of new concepts, and academics need to be aware of the context in which policy is developed. And as in other areas, policy innovation is usually needs-driven. A new academic concept will not by itself initiate changes in policy, but when a need arises (usually in the form of a crisis), a good policy analyst will try to see if the new concepts he has picked up can help formulate policy.

Indeed, looking back we can see that the whole field of innovation research was developed in interaction between pioneering academics and organizations like the Six Countries Program and the OECD.

References:

Abernathy W. J. and Utterback, James M (1978). "Patterns of industrial innovation". Technology Review, Vol. 80 (June-July).

Arthur, W. Brian (2009), "The Nature of Technology: What It Is and How It Evolves", Free Press

Broström, Anders (2009) Ph.D. Dissertation: "Strategists and Academics – essays on interaction in R&D", Royal Institute of Technology.

Dahmén, Erik (1988) " 'Development blocks' in industrial economics", Scandinavian Economic History Review, Volume 36, Issue 1, pp 3-14

David, Paul A. (1990), "The Dynamo and the Computer: An Historical Perspective on the Modern Productivity Paradox", American Economic Review, Vol. 80, No. 2, pp 355-61

Dosi, Giovanni; R. Gianetti; P. Toninelli (Eds., 1992): "Technology and Enterprise in a Historical Perspective". Oxford University Press.

Elg, Lennart & Staffan Håkansson (2012) "Impacts of innovation policy", VINNOVA VA 2012:01

Eliasson, Gunnar, Åsa Eliasson, Dan Johansson, Ann-Charlotte Fridh, Clas Buttwill (2005) "The Birth, the Life and the Death of Firms : the role of Entrepreneurship, Creative Destruction and Conservative Institutions in a Growing and Experimentally Organized Economy", Ratio

Henderson, Rebecca M. & Clark, K.B. (1990) "Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms", Administrative Science Quarterly, vol.35 no.1, pp. 9-30

Håkansson, Håkan & I. Snehota (1989) "No business is an island: The network concept of business strategy", Scandinavian Journal of Management, Volume 5, Issue 3, 1989, Pages 187-200

Jacobsson, Staffan, Eugenia Perez Vico (2010) "Towards a systemic framework for capturing and explaining the effects of academic R&D", Technology Analysis & Strategic Management Vol. 22, Iss. 7

Jensen, M.B., B. Johnson, E, Lorentz & B-Å Lundvall (2007) "Forms of knowledge and modes of innovation", Research Policy, Vol. 36, # 5, June 2007, Pp 680–693.

Kay, John (2011) "Why we struggle with our roulette wheel world", Financial Times, 16 March 2011

Leijten, Jos & Torsti Loikkanen (2015), "40 years of innovation policy research - lessons from the past and future outlook", Background paper for the Six Countries' 40th Anniversary Workshop, Vienna (in this volume)

Loorbach, Derk (2010) "Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance" Governance: An International Journal of Policy, Administration, and Institutions, Vol. 23, No. 1, January 2010 (pp. 161–183).

Lundvall, Bengt-Åke, ed. (1992), "National Systems of innovation: Towards a theory of innovation and interactive learning", Pinter Publishers

Lundvall, Bengt-Åke (2005), "National Innovation Systems – Analytical Concept and Development Tool", Paper presented at the DRUID Tenth Anniversary Summer Conference, Copenhagen, Denmark June 27-29

Martin, B.R., Tang, P. (2007) The benefits from publicly funded research. SPRU Electronic Working Paper Series, Brighton.

Office of Science and Technology (2004): “The Impact of the EU Framework Programmes in the UK”, July

Perez Vico, Eugenia (2013) Ph.D. Dissertation: “The Impact of Academia on the Dynamics of Innovation Systems - Capturing and explaining utilities from academic R&D”, Chalmers University of Technology.

Rosenberg, Nathan (1982) “Inside the Black Box: Technology and Economics”, Cambridge University Press

Rothwell, Roy, C. Freeman, A. Horlsey, V. T. P. Jervis, A. B. Robertson, J. Townsend (1974) SAPPHO updated - project SAPPHO phase II. Research Policy

Salter, A.J., D’Este, P., Pavitt, K., Scott, A., Martin, B.R., Genua, A., Nightingale, P., Patel, P. (2000). “Talent, Not Technology: The Impact of Publicly Funded Research on Innovation in the UK”. SPRU, University of Sussex

Taleb, Nassim N. (2007) “The Black Swan – the Impact of the Highly Improbable”, Randow House

Utterback, James M. (1994) “Mastering the Dynamics of Innovation”, Harvard Business School

VINNOVA (2008) “Impacts of the Framework Programme in Sweden”, VINNOVA VA 2008:11

The 6 Countries Programme (6CP)

Jos Leijten and Ken Guy

The 6 Countries Programme (6CP) was initially termed the 6 Countries Project. It started in 1975 as a network of people wanting to collect evidence about the need and effectiveness of innovation policies and to learn from each other. Those involved felt a need to create opportunities for mutual learning on the topic between international peers in policymaking, research and industry. At the time, the only existing forum for such international debate and learning was the OECD, which was felt to be too formal and too constrained by the dominance of traditional macro-economists.

The 6CP was started by individuals from organisations based in six countries (the UK, the Netherlands, Germany, France, Sweden and Canada), which explains the name. This 'people-based' network met once or twice a year in a workshop or conference to discuss a topic or topics decided by a steering committee and prepared by one of the members. Funding was taken care of by the members' home organisations. The prime goal was always to bring together a good mixture of researchers, policy makers and industrialists.

As innovation policy started to receive more interest in government circles, the involvement of ministries grew and in several cases, they became the prime participants and funders - transforming the network into a 'country-based' network in the process. By 1995, around 12 or 13 countries were officially involved as paying members and many other countries participated. Despite this growth, however, the 'brand name' 6CP was retained.

The first 6CP workshop with 'innovation policy' in its title was held in 1977. This was entitled: 'The Current International Economic Climate and Policies for Technical Innovation' (November 1977). Since then, many more have followed.[87] Over the years, more than 2000 researchers, policy makers and industry representatives have participated in these events. Some attended because of the specific topic of the workshop and/or because the location made it convenient to participate. But there was also a relatively stable core of between 100-200 people.

Gradually, however, the fora available to both governments and researchers for mutual learning increased considerably. The networking of governments was especially facilitated by the adoption of processes such as the Open Method of Coordination (OMC) within the European Union and, more globally, by the expanded activities of the OECD's Directorate for Science, Technology and Industry[88] (DSTI) and its various Committees and Working Parties. University-based researchers also benefitted from the existence of new government-sponsored networks facilitating the presentation and discussion of academic research on innovation and innovation policy.

By 2005, therefore, it had become clear that the priority accorded by governments to new intergovernmental and international academic networks and activities obviated the need for the continued existence of the 6CP as a 'country-based' network. The 6CP steering committee thus decided on a return to its 'people-based' origins, with the network reverting to its status as an occasional forum for the open exchange of views on innovation policy at the forefront of developments in the field.

In 1975, the debate about innovation policy focused (in the words of Thierry Gaudin, one of the founders) on:

87 See the full list of events at 6CP.net.

88 Now the Directorate for Science, Technology and Innovation.

- How to create new business opportunities through large scale mission driven technological projects ('grand projects')?

- How to best support SMEs as important drivers of innovation, jobs and economic growth?

- How to develop the "technological culture" which makes sure that new developments are well-embedded in society?

Other topics subsequently considered by the network are reflected not only by the workshop titles listed at 6cp.net, but also by some of the more important publications that have been based on material presented in these workshops. These include:

- Roy Rothwell and Walter Zegveld (1978), 'Small and Medium-sized Manufacturing Firms: Their Role and Problems in Innovation-Government Policy in Europe, the USA, Canada, Japan and Israel', Report to Six Countries Programme on Innovation, TNO, Delft, Netherlands, June.

- Roy Rothwell and Walter Zegveld (with foreword by Christopher Freeman) (1979), 'Technical Change and Employment', St. Martin Press, New York.

- Roy Rothwell and Walter Zegveld (1981), 'Industrial Innovation and Public Policy: Preparing for the 1980s and 1990s', Frances Pinter (Publishers), London.

- Christopher Freeman (1982), 'The Economics of Industrial innovation', Frances Pinter (Publishers), London.

- Christopher Freeman, John Clark and Luc Soete (1982), 'Unemployment and a Technical Innovation: A Study of Long Waves and Economic Development'. Frances Pinter (Publishers), London.

- Dermont O´Doherty (Ed.) (1995), 'Globalisation, Networking and Small Firm Innovation', Six Countries Programme and Forfás, Graham & Trotman.

- Paul Sweeny (Ed.) (2001), 'Innovations, Economic Progress and the Quality of Life', Edward Elgar.

- Mariagrazia Squicciarini and Torsti Loikkanen (Eds.) (2008), 'Going Global – The Challenges for Knowledge-Based Economies', Publication of the Ministry of Employment and the Economy, Innovation 20/2008.

- Lennart Elg and Jos Leijten (Eds.) (2010), 'New Economic Ground for Innovation Policy', Cultiva, Coleccion Estudios. Número 143.

- 6CP (2015), 'Can Policy follow the dynamics of global innovation platforms?', Papers from a 6CP conference, 14-15 April, 's-Hertogenbosch.

Within this collection of contributions honouring Walter Zegveld, the chapter by Jos Leijten and Torsti Loikkanen ('Forty Years of Innovation Policy Research - Lessons and Outlook') offers further perspectives on some of the important policy developments covered and even shaped by discussions that have taken place within 6CP workshops over its lifespan.

Agenda: What would Walter say? 50 years of innovation politics

Date, Venue: 16 December; Koninklijke Schouwburg, Korte Voorhout, Den Haag

9:30	Registration, Coffee	
10:00	Opening	Jos Leijten Wolfgang Polt Thierry Gaudin Marc Zegveld
Chair: Gustavo Fahrenkrog		
10:30	An engineer/practitioner in the wake of Schumpeter and evolutionary economics	John Hagedoorn
10:45	The advent of S and T and I policy.	Peter Tindemans
11:00	The Vienna 6CP-40 workshop: summary	Ken Guy
11:15	A view from the US	Nicolas Ashford
11:30	Break	
11:45	a. Large scale mission driven technological projects (grand projets) as a keypolicy instrument b. Dual technologies c. ICT	Patries Boekholt Christien Enzing Jos Leijten
12.30	Industrial policy perspectives	Jeroen Heijs
12:45	Interactive	
13:00	Lunch	
Chair: Jos Leijten		
14.00	a. Policies for diffusion of innovation b. Public-private partnerships for innovation	Frits Prakke Frans van der Zee
14:30	a. Constructive) technology assessment, Foresight and Impact b. Technology and employment c. Services Innovation	Torsti Loikkanen Wolfgang Polt Pim den Hertog
15.15	Europe and the politics of innovation	Jean-Claude Burgelmanw
Chair: Ken Guy		
15:30	Roundtable/interactive	Peter Tindemans, Frank Pot, Jean-Claude Burgelman, Nicolas Ashford and all
16:15	To conclude: for new dynamics?	Luc Soete
16:45	Closing words	Wolfgang Polt/Jos Leijten
17.00	Drinks	

