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CHALLENGE-ORIENTED POLICY-MAKING AND INNOVATION SYSTEMS THEORY:

RECONSIDERING SYSTEMIC INSTRUMENTS

STEPHANIE DAIMER, MIRIAM HUFNAGL, PHILINE WARNKE[1]

11.1 Introduction

In their attempt to analyse the "rise of systemic instruments", Smits and Kuhlmann (2004, pp. 5–8) identify three trends that characterise the "changing nature of innovation processes and systems":

- the end of the linear model
- the rise of the systems approach and
- inherent uncertainty and need for learning

They argue that – as a consequence of these trends – systemic instruments increasingly complement classical approaches in the innovation policy portfolio (Smits and Kuhlmann, pp. 11ff.). Recently, however, the dominant rationale of innovation policy seems to be changing. Increasingly, innovation policy is expected to contribute towards addressing societal demands or even to respond to the "Grand Challenges of our time".

The Lund Declaration of 2009, which was assigned by a large group of policy-makers, researchers and business representatives to the Presidency of the European Council, for example stated that these "[...] challenges must turn into sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security. [...] Responses to Grand Challenges should take the form of broad areas of issue-oriented research in relevant

1 Equal co-authorship.

fields".[2] This "normative turn" in innovation policy implies changes in the requirements of its instruments. Therefore our contribution seeks to revisit established notions of system-oriented innovation policy patterns in the light of the new "grand challenge-oriented" paradigm on research and innovation policies. We will discuss whether current systemic innovation policy instruments are suitable to implement a challenge-oriented innovation policy. A reflection on the now well established innovation system approach underlines that this heuristic concept focuses on the well-functioning of the system, but does not provide for a strategic or normative orientation. Such an orientation function is suggested here, followed by a few practical considerations on how this function could be translated into innovation policy, i.e. how systemic policy instruments would need to be further refined in order to address the strategic orientation of the system.

We start by describing the growing relevance of the notion of the "Grand Challenges" as a normative, strategic goal of innovation policy (Section 11.2). Section 11.3 will briefly summarise recent changes in the nature of innovation, while Section 11.4 illustrates implications posed by the system of innovation approach as the underlying heuristic of most of today's innovation policies. Section 11.5 asks whether systemic policy instruments, which are designed to address the new nature of innovation, are also suited to address new requirements of research and innovation activities implied by the normative turn of innovation policy. Here, we outline our main proposition of how an orientation function should be introduced in order to permit the normative orientation the "Grand Challenges" call for in policy-making. After these conceptual considerations, we illustrate our conclusions by analysing two prominent systemic instruments in Section 11.6, namely participatory evaluation and foresight. For both instruments we will explore how the requirements of challenge-oriented innovation policy impact on the rationale and implementation of the approach. This will finally allow us to derive possible refinements of systemic innovation policy instruments in the context of challenge-oriented innovation policy.

11.2 The normative turn of innovation policy

Innovation policy has gone through several paradigm shifts. Early attempts in the 1960s tried to balance "market failures" through funding certain basic research activities. This was followed by various forms of "mission-oriented schemes" that aimed at specific targets such as the US Apollo 1 space program; lately the innovation systems school is addressing "system failure" by enhancing systems' learning capability, by trying to improve the management of interfaces as well as by building up the capacity of different actors in the system.

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2 As stated during the Swedish Presidency of the European Union in July 2009: The Lund Declaration – Europe must focus on the Grand Challenges of our time, online: http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_9_july.pdf, accessed 4 May 2012, http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_9_july.pdf.

Each paradigm emphasised different policy instruments such as direct funding of research and development, demand-side instruments (e.g. public procurement, establishment of lead markets) or systemic instruments.

Braun (2008) delineates three phases of innovation policy, the first representing the classic mission orientation. Yet the combination of instruments in a well-balanced policy mix has been emphasised since the 1980s. This second phase was characterised by the fact that the assumption of an automatic occurrence of spill-over effects from basic research to immediate application in business and industry was questioned, and the identification of non-linear, recursive interactions of heterogeneous actors became prominent in innovation studies. Still, policies solely targeted selected sectors and technologies during this phase of innovation policies. It was only with the establishment of the innovation system approaches in the 1990s that "innovation has come to be seen as the interplay of market and non-market forces and as denoting a policy of 'structuration', of framework-setting that helps to correct 'market failures' and improve interaction, within the 'innovation system'"(Braun 2008, p. 227). Notably, an important characteristic of the development of innovation policies is the fact that established forms of support measures, respectively policy instruments, were not necessarily replaced by new policy paradigms but complemented (Boekholt 2010; Gassler et al. 2006). Early innovation studies had shown that some countries were developing faster than others in spite of similar economic circumstances due to different characteristics of their innovation systems. Consequently, the idea was established of optimising "innovation ecosystems" in order to enhance innovation capability and thereby foster economic growth and competitiveness.

This rationale has been complemented in recent years. Besides competitiveness and innovation capability, several innovation policy strategies aim to foster innovation that addresses the "Grand Challenges of our times" such as health, sustainability, mobility and security and thus contribute to better living conditions worldwide. Prominent examples are the US "Strategy for American Innovation", the EC's Europe2020 strategy and the German "High-tech Strategy". In parallel, the notion of economic growth as the key driver of innovation policy is under consideration. Particularly in the wake of the current financial crises the "limits of growth" already indicated by the Club of Rome in 1972, are of public concern. Specifically, the focus on the Grand Challenges calls for indicators that not only reflect a focus on the mere quantity of the economic output and market-based innovation, but also display qualitative issues of contentment, well-being and happiness. Though this debate is beyond the scope of this contribution, it is still important to keep these aspects in mind when reflecting on implications of this normative turn in the nature of innovation activities and the fit with the innovation system approach.

11.3 Changes in the nature of innovation

For decades the dominant definition of innovation as "new products and processes that are successfully introduced to the market" was hardly ever questioned. Companies were considered the key actors of innovation landscapes and the number of

science-based high-technology innovations was deployed as the most relevant measure of innovation capability. Nowadays, a new understanding of innovation is gradually emerging from a number of different directions.[3] Increasingly, phenomena like social innovation, service innovation, low-tech innovation, frugal innovation, relational innovation and value innovation are being recognised as highly relevant innovation arenas that are challenging the standard definition (among others, see Kim and Mauborgne 1999; Miles 2005; Mulgan et al. 2007). At the same time, with the notion of "open innovation" and corresponding practices such as "crowdsourcing" (Howe 2006) and "co-creation" (Prahalad and Ramaswamy 2004), the focus on the firm as the key innovation actor has substantially broadened towards social entrepreneurs, users, customers, the public sector and citizens (Chesbrough 2006; Reichwald and Piller 2006). Creativity and innovation capability is no longer exclusively assigned to specific professions such as designers and artists or entrepreneurs, but extends to "ordinary people" and everyday life (Miller et al. 2008). This goes hand in hand with a perception of innovation as a local phenomenon that is emerging across the globe wherever it is required and not just exclusively in a few innovation hubs. At the same time, markets are complemented as the main coordination mechanisms between innovation demand and supply. Due to the lowering of transaction costs caused by the widespread use of the internet and mobile devices, more and more services are being coordinated directly between the parties involved through "peer to peer production" on the base of shared common goods (Benkler 2006).

At the same time, the "normative turn" in innovation policy outlined above is creating demand for different types of innovation patterns. Findings from innovation studies indicate that addressing the Grand Challenges requires much more than just replacing the topics of RTI funding programmes; indeed a different type of research and innovation projects altogether is called for. In particular, the following characteristics of challenge-driven innovation activities have been proposed:

- *socio-technical*
  aligning social and technological innovation
- *systemic*
  focusing on system change rather than on individual elements alone
- *transition-oriented*
  Envisaging system transition rather than only incremental trajectories
- *experimental*
  providing spaces for experimenting with socio-technical and system innovations in the real world
- *glocal*
  mobilising and aligning a diverse range of local solutions to address grand challenges on a global level

3 See also the recently finalised Foresight project on the "future of innovation" INFU where eight dimensions of change in innovation patterns were highlighted (www.innovation.futures.org).

– *transdisciplinary*
  joint research and innovation across disciplines
– *participatory*
  involving users and providers as well as stakeholders in joint learning processes around innovation trajectories

Steward (2008) suggested the term "transformative innovation" for this type of innovation pattern. Joly et al. (2010) propose the concept of "collective experimentation" to characterise such "transformative" innovation journeys directed at societal issues. Other studies have emphasised that challenge-driven innovation also implies different types of scientific research. In a recent memorandum, a scientific council of the German Chancellor proposed a shift towards "transformative research" in order to address climate change (WBGU 2011). These demands have unleashed a debate on the appropriate balance between curiosity-driven and challenge-driven research and the institutional setting required to underpin this balance which is still ongoing.

To sum up, we can say that changes in innovation patterns are driven by the dynamics of socio-economic framework conditions and newly emerging technologies, on the one hand, and by new policy demands, on the other. Before turning to the implications for systemic innovation policy instruments, which is the focus of our contribution, we will now briefly revisit the system of innovation approach which forms the basis for the notion of systemic instruments.

11.4 Grand challenges and innovation systems

The field of research and innovation policy is characterised by multi-actor and multi-level structures, without one hierarchical-statist centre. This observation is acknowledged within innovations system approaches. Freeman's concept of national (or regional) innovation systems was the first attempt to illustrate a broad interaction between all types of institutional networks in the private and public sector "whose activities and interactions initiate, import, modify and diffuse new technology" (Freeman 1987, p. 1). This conceptual framework was followed by other systems of innovation approaches focusing on different aspects besides national (Freeman 1987; Lundvall 1992; Nelson and Rosenberg 1993; Edquist 2005) and regional innovation systems (e.g. Braczyk et al. 1998), like technological (e.g. Carlsson and Stankiewicz 1995) or sectoral ones (e.g. Malerba 2002). However, common to all approaches is the assumption that innovations as such are embedded within the systemic context of all relevant stakeholders and institutions (cf. Chapter 1). Innovations come to life under complex, iterative circumstances since they "[...] encompass [...] the 'biotopes' of all those institutions which are engaged in scientific research and the accumulation and diffusion of knowledge, which educate and train the working population, develop technology, produce innovative products and processes, and distribute them. Hereto belong the relevant regulatory bodies (standards, norms, laws), as well as the state investment in appropriate infrastructures" (Kuhlmann et al. 2010, p. 3).

While the neo-classical, linear view of innovation referred to market failures as a rationale for state interventions, this evolutionary view of innovation has brought

forward systemic failures to justify state interventions and the involvement of state actors. Among others, Chaminade and Edquist point to the different lines of theoretical reasoning: "market failure in mainstream economic theory implies a comparison between conditions on the real world and an ideal or optimal economic system. However, innovation processes are path dependent over time, and it is not clear which path will be taken as they have evolutionary characteristics. [...] what is more, the system never achieves equilibrium, and the notion of optimality is irrelevant in an innovation context" (Chaminade and Edquist 2006, p. 115). In practice, the different existing categorisations of market and system failures show that the types of imperfections are often not formulated in such a way that they can be sharply differentiated from one another and that various links exist. The current consideration of "systemic imperfections" (Woolthuis et al. 2005, p. 610) has been broadened over the past years and now includes different types identified and formulated by various scholars in the field (among others, Smith 2000; Woolthuis et al. 2005; Chaminade and Edquist 2006): infrastructure provision and investment problems, transition problems, lock-in problems, hard and soft institutional problems, network problems, capability and learning problems, unbalanced exploration-exploitation mechanisms, and complementarity problems. All these aspects of "systemic imperfections" reflect a gradual gain in knowledge in innovation research and innovation-related policies whose foundation has been – and still is – an improved understanding of the relationship between research, innovation and socio-economic development (Soete 2007, p. 278): "Sectoral explanations of either technology push or demand pull kind have gradually lost in policy influence. Instead, it is now widely recognised that economic growth and well-being is founded in a much broader, well-functioning 'knowledge and innovation system', in which all actors perform well."

Despite all the refined understanding of innovation systems, the instruments derived from the innovation system approach are mainly directed at enhancing the innovation ecosystem in order to strengthen innovation capability. So far, there is no attempt to build on the innovation system heuristic in order to modulate innovation journeys towards certain desirable objectives. So whereas system failure appears to be addressed, "orientation failure" has largely not been tackled. Systemic instruments and orientation failure.

11.5 Systemic instruments and orientation failure

The question is whether systemic policy instruments, which are designed to address the capability of innovation systems, are also suited to address new requirements of research and innovation activities implied by the normative turn of innovation policy.

Our hypothesis is the following: introducing any kind of goal orientation into complex innovation landscapes and modulating innovation trajectories requires intimate understanding of innovation systems. The orientation function can be introduced into the system only when "government" is seen as the potential "orchestrator" of the system (Shapira et al. 2010, p. 461). Systemic policy-making that allows for coordination of different parts of the system (sectors, subsystems, etc.) and engages

them in discursive processes (reflexive governance, transition management), is the precondition for successful strategic policy-making. Accordingly, imposing grand challenges as a major rationale of policy and hence a major goal of research and development by a top-down organised process will most likely not lead to any real transformative innovation, but will rather lead to subsuming previous research under new headlines like putting "old wine into new bottles". Thus any innovation policy instrument underpinning transformative governance will have to embrace the notion of systemic instruments. At the same time, nurturing innovation ecosystems alone will not be sufficient. Systemic and strategic policy-making needs to be connected. Such a connection may draw on experience from policy realms with longstanding experience in strategic policy-making, such as sustainability policy. Concepts like transition management, strategic niche management (Loorbach 2010) and constructive technology assessment (Schot and Rip 1996) may provide valuable starting points.

This governance aspect of programmatic strategies is also implicitly put forward by a former OECD expert: "An innovation strategy [...], has to take account of [cultural, geographical, legislative and regulatory] conditions to ensure that any interventions combine to contribute to the policy goals and do not weaken one another [...] with emphasis on whole-of-government policies" (Gault 2010, pp. 92ff.). The identification of "whole-of-government policies" is a very important and increasingly observable feature of programmatic strategies, like for instance, the German High-tech Strategy. According to Susana Borrás, an important criterion for strategic innovation policy is the "evidence that the vision and priorities are transposed to the choice, design and implementation of innovation policy instruments" (Borrás 2009, p. 15). Whether or not this statement holds true for the already mentioned programmatic strategies is subject to evaluations in the near future. Yet considerably more research must be carried out to further define the composition, must-have features and application modes of strategic policies altogether. In order to address this conceptual shortcoming in terms of a coherent definition of programmatic strategies, we would like to undertake some practical considerations about the elements of such policies, namely, the policy instruments.

11.6 Aligned systemic and strategic policy-making: some practical considerations

From the point of view of innovation policy, it seems obvious that challenge-oriented innovation requires different types of supporting instruments and therefore narrow types of demand articulation no longer seem adequate. However, it is still little understood whether and how this type of innovation can be fostered by innovation policy. Several current challenge-driven innovation policy strategies embrace measures to address some of the characteristics of "transformative innovation" (cf. Warnke 2012 for a recent overview). The Europe 2020 strategy explicitly calls for novel combinations of policy instruments and new foci of established instruments[4]. It is widely

4 "Member States should seek to shift the tax burden from labour to energy and environmental taxes as part of a 'greening' of taxation systems." (European Commission 2010, p. 26).

acknowledged that picking the winners among key technologies – be it in terms of competitiveness or in terms of supposed contributions to abstract societal goals – will no longer do the job. Rather, options for socio-technical transition need to be identified by linking up technological and societal change into "configurations that work" in new transformative ways. But what kinds of instruments are suitable to address this?

Besides the classical canon of policy instruments that mainly fund, regulate or either provide or gather information – Bemelmans-Videc et al. (2007) also describe the set rather vividly as "carrots, sticks and sermons" – the category of systemic instruments already seems to be part of the answer, since they incorporate specific needs of innovation policy, respectively, the level of systemic management of innovation processes (Hufnagl 2010). The key feature of systemic instruments is "that they aim to address problems that arise at the innovation system level and which negatively influence the speed and direction of innovation processes" (Wieczorek and Hekkert 2012, p. 74). According to the advancing debate in innovation studies over the past years, Wieczorek and Hekkert (2012, p. 82) provided an extended and enhanced overview of the goals of systemic instruments, building on the work of Smits and Kuhlmann (2004) to:

1. stimulate and organise the participation of various actors (NGOs, companies, government etc.)
2. create space for actors' capability development (e.g. through learning and experimenting)
3. stimulate the occurrence of interaction among heterogeneous actors (e.g. by managing interfaces and building a consensus)
4. prevent ties that are either too strong or too weak
5. secure the presence of (hard and soft) institutions
6. prevent institutions being too weak or too stringent
7. stimulate the physical, financial and knowledge infrastructure
8. ensure that the quality of the infrastructure is adequate (strategic intelligence serving as a good example of specific knowledge infrastructure)

Prominent examples of systemic instruments that "influence the speed and direction of innovation processes" and therefore address transition goals is transition management and strategic niche management (Loorbach 2010; Kemp and Rotmans 2009). However, there is no widespread application of those instruments (beyond the Netherlands) and they were implemented for rather specific goals. In a similar way, the technological innovation system approaches explicitly target change in a specific direction, for instance, the uptake of a certain technology that is thought to be more desirable than others e.g. in terms of ecological impact. Finally, several scholars have proposed "demand-oriented innovation policy strategies" (Edler 2010). Rather than trying to address societal demand, these strategies deploy demand-side measures in order to foster technological innovation with no specific societal goal apart from spurring innovation.

Therefore, we see the need to further advance these and other systemic instruments in order to address the strategic orientation of the system. To convey our ideas in this regard, we chose participatory evaluation and foresight processes as illustrative examples of classical systemic instruments that need to evolve in order to underpin transformative governance approaches.

11.6.1 Participatory evaluation: Addressing normative challenges through new impact dimensions and behavioural additionality analysis

Evaluation can be understood as the study of the use or (added) value of the subject of analysis, based on academic standards considering relevant empirical data. In the field of research, technology and innovation policy, evaluation can have the following different subjects of analysis: research projects, actor networks, clusters, institutions or organisational entities, processes, (funding) programmes and other policy instruments or policies. Furthermore, evaluations of whole sectoral or national innovation systems are carried out. The evaluation of funding programmes and other policy instruments is of highest relevance in the field of innovation policy (e.g. Arnold and Guy 1997; Fahrenkrog et al. 2002; Miles et al. 2005; Edler et al. 2010) and is therefore the main subject of the subsequent thoughts. The basic purpose of evaluations can be either summative or formative and each programme evaluation can cover different aspects, such as appropriateness and consistency, effectiveness and efficiency or impacts.

Evaluation is not per se understood as a systemic policy instrument. In a more classical view, the main functions are legitimation, control, insight and understanding or learning. In the evolutionary understanding, learning is most important and policy evaluation is regarded as a source of strategic intelligence (Kuhlmann 2002) "providing actors with the information they need to develop and implement their strategies" (Smits and Kuhlmann 2004, p. 9) or to stimulate the occurrence of interactions by building consensus among the actors (Wieczorek and Hekkert 2012, p. 85). In classical evaluation studies, stakeholder involvement is often uni-directional; this means that they are involved via surveys and similar methods to provide the relevant empirical data. Thus in a systemic perspective, evaluation can be regarded as bi-directional, i.e. evaluations should ensure that relevant information is provided in a useful manner to the stakeholders and that feedback loops to the involved actors are established, in order to provide room for learning, which eventually leads to improving systemic capabilities. This bi-directionality allows us to speak of real stakeholder participation.

With our proposition as to how evaluation could be applied as a systemic instrument by adding participatory elements, the question remains how it could provide orientation in the strategic, normative sense outlined above. This is defined by the policy programme subject to the evaluation, i.e. by its goals and the terms of reference of the evaluation. Programme goals can be formulated normatively or challenge-oriented in two different ways:

– They are either defined as external goals, i.e. impacts reaching beyond the programme participants. such as contributing to less environmental pollution or

addressing issues of demographic change, or they formulate a sustainable long-term effect on the participants, i.e. a change of behaviour. In the first case, this means covering new impact dimensions beyond mere economic or technological impacts, such as sustainability or social impacts (beyond the programme participants) during the evaluation. As these new impact types occur rather intangibly in the wider society or the environment and are of a qualitative nature, they are hard to measure. Our proposition is that, in these cases, a participatory evaluation approach involving experts and different societal groups is a suitable way to include these issues. By studying new impact dimensions, participatory evaluation would need to go beyond the systemic character of evaluation sketched above.

– In the second case, the evaluation will also need to assess any transformative impacts on the actors, i.e. evidence of behavioural additionality, understood here as a change in the persistent behaviour related to R&D and innovation activities (Gok 2010).[5] In the same way as evaluation can be used as a systemic instrument to strengthen the systemic capabilities of the actors, it could be used to trigger the normative orientation of the actors. At best, the orientation function could eventually be implemented in evaluation studies by combining a participatory approach through the analysis of behavioural additionality.

In practice, however, a purely systemic participatory evaluation approach and an evaluation approach which goes beyond the systemic character and adds a normative or challenge orientation, both face implementation difficulties as the following considerations show:

– Participatory evaluation in the described systemic sense is not a common approach in evaluation practice. The feedback loops and formats like focus groups or workshops are time-intensive and can hardly be realised in short-duration contracts.
– Secondly, clients and evaluators need to share the same intentions about the evaluation. Accordingly, they must agree on the participatory approach, which obviously requires a high level of transparency of information. An example is the accompanying evaluation of the German funding programme VIP ("Validation of the Innovative Potential of scientific research"). The programme is an innovative element in the German funding landscape which aims to bridge the gap between basic research and applied R&D for marketable products. One of the goals is to strengthen the knowledge transfer and valorisation culture at academic institutions. In order to achieve this, the evaluation set out to engage the target group (researchers at publicly funded institutions) in different formats in order to contribute to a more sustainable transfer culture.
– Thirdly, participatory evaluation generates challenges to principles of good practice of evaluation, as evaluators are no longer in the role of impartial observers, but take an active part in generating impacts and shaping reality. Thus,

5 He elaborates on at least three other conceptualisations of the term in literature.

defending impartiality, independence and credibility becomes a constant task for evaluators in a participatory setting.

- The INNO-Appraisal project which compared a large number of evaluations across Europe has shown that formative evaluations, although quite numerous, do not exploit their full potential of actor involvement and learning: "Evaluations which are (at least partly) summative tend to be more often widely discussed within government and with participants/stakeholders than formative evaluations. Even if the differences are not statistically significant, it appears the results of summative evaluations, with clear 'numbers' and messages, are better suited for wider discussion, while the virtue of formative evaluation is not so much their dissemination, but the learning within the process itself" (Edler et al. 2010, p. 78).
- Another result of the project is the insight that studying new impact types (as required by challenge-oriented programmes) is not as uncommon as one might think: Almost half of the studies cover social impacts, almost one third cover environmental impacts (Edler et al. 2010, p. 132). However, this high account is linked to the high number of structural fund evaluations in the sample, and the requirement by the European Commission as a sponsor to cover economic, social and territorial cohesion in the evaluation studies (ibid., pp. 127, 136).
- The measurement problem for these new external impact types was already mentioned. A participatory approach is suggested here, however, the task of thinking about new measurement methods for social and environmental impacts in the future still remains.
- As for behavioural additionality, the INNO-Appraisal project again finds that a large number of evaluations use this concept (Edler et al. 2010, p. 127). Thus "behavioural additionality is mainly linked to direct economic impacts" (ibid., p. 139), while social impacts such as the promotion of innovation mentality, changes of risk attitudes, the awareness of societal needs, acceptance of technology or attitudes towards entrepreneurship are studied more rarely with this concept.
- Moreover, "interestingly, and neglecting its full potential, behavioural additionality is not as common in accompanying evaluations as one would assume, given the focus on interaction and learning and the need to re-adjust programme and implementation should learning effects not be observed in real time. The concept is used in formative evaluations, but not as extensively as one would think" (Edler et al. 2010, p. 154).

These considerations show that there is still a large potential for implementing evaluation as a systemic instrument, and beyond this, as an instrument to evaluate normative and challenge-oriented programmes.

11.6.2 Foresight processes: Identifying strategic priorities through joint learning processes

Foresight processes set up strategic conversations among key actors of innovation systems, thereby providing platforms for joint learning processes, combining

heterogeneous elements and ultimately "wiring-up innovation systems" (Martin and Johnston 1999). In the context of innovation policy, Foresight is a systemic instrument par excellence. For more than a decade, European Foresight practitioners have been emphasising the benefits of the Foresight process for the learning capability of innovation systems. "Wiring-up innovation systems" through the "process benefit" of Foresight exercises was thought to be of equal relevance to the anticipatory intelligence arising from the actual findings of Foresight processes. Foresight, so it is argued, engages diverse actors in a joint learning process, thus creating future-oriented attitudes and linkages and therefore ultimately enhancing the responsiveness of the innovation system towards future challenges. Many Foresight processes in the realm of research and innovation policy set out to define priorities for public support for research and innovation activities. In doing so, most Foresight exercises aimed at identifying "key technologies" and selecting the ones that seem most promising to underpin the competitiveness of domestic industry through prospective debate among key stakeholders (Salo and Cuhls 2003). Typical examples are the French "Étude Technologies clés"[6], the Spanish "Ejercicio de Prospectiva a 2020"[7] and the Foresight process launched by the German BMBF from 2007–2009 (Cuhls et al. 2009). Such Foresight studies requested top experts to assess the contributions of key technologies to demand criteria such as quality of life, quality of environment and social cohesion. Even though these processes used societal benefits such as selection criteria, the demands themselves were usually taken as a given fact. Only few processes such as the German FUTUR exercise provided space for value debates and normative Foresight approaches. Thus, while the provision of orientation is an explicit goal of Foresight as an innovation policy instrument, the "orientation failure" inherent in the systemic instrument approach was reflected by most Foresight processes. Accordingly, the normative turn of innovation policy, on the one hand, and the changes in the nature of innovation that were described in the previous sections pose new requirements for Foresight processes. In the FORLEARN process, that was set up by the European Commission through the JRC IPTS in 2006 in order to foster exchange and capture of Foresight knowledge across Europe (Da Costa et al. 2008), the need for more normative Foresight elements was highlighted.

– Another issue gaining relevance in the context of systemic instruments for demand-oriented innovation policy is the uptake of insights from social sciences and humanities. In many Foresight processes, societal evolution was tackled in much less depth than technological trajectories and engineers far outnumbered social scientists among Foresight coordinators and participants (Warnke and Heimeriks 2008).

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6 Étude Technologies clés 2010, online: http://www.industrie.gouv.fr/techno_cles_2010/html/sommaire.php (accessed 4 May 2012).

7 Estrategia Nacional de Ciencia y Tecnología (ENCYT) 2020. Ejercicio de Prospectiva a 2020, online: http://icono.fecyt.es/informesypublicaciones/Documents/ENCYT_prospectiva.pdf (accessed 4 May 2012).

- Instead of "wiring-up" the known "key actors" of the innovation system in terms of different contributors to technological innovation, joint learning processes between technological AND societal innovators are required. Different socio-technical trajectories need to be debated and assessed. For this, Foresight processes need to reach out to civil society as a whole. Rethinking patterns that are deeply entrenched in our culture, such as the close knit between economic growth and quality of life, requires much broader notions of "stakeholder" or "expert". New, diverse actors such as social innovators, artists, children, immigrants, the global poor, animals and robots come into the picture.
- Both sides of the coin, the "socio" and the "technical", need to be tackled with an equal level of complexity. Social innovation needs to be factored in. Accordingly, expertise from the social sciences and humanities need to be recruited at an equal level with technology expertise.
- New methods are required in order to facilitate value debate and to imagine new working configurations. Analytical prospective methods such as scenario building, Delphi surveys and cross-impact analysis need to be complemented by methods that mobilise emotions and tacit assessments such as visioning processes or approaches from ethnographic design.
- Traditionally, Foresight exercises placed great emphasis on consensus building. However, in order to address Grand Challenges, consensus might have to be challenged in some cases. Addressing issues such as global climate change involves rethinking fundamental value notions such as global justice (Hulme 2009). Foresight processes that seriously venture towards this challenge need to avoid premature closure on easy fixes and actively bring these conflicts into the open. In other cases, a greater diversity of solutions may have to be fostered in order to break out of lock-in situations (Könnölä et al. 2007).
- In several cases, transformative innovation will require rethinking established paradigms. Rather than extrapolating today's trends, we need to imagine change in the conditions of change in order to discover the transformative potential of the present (Miller 2007). Methods that underpin exploration of new paradigms are likely to gain relevance (Schirrmeister and Warnke 2012, forthcoming).
- Even though dialogue and, in particular, value debate and socio-technical scenario building are key elements of socio-technical transition, they are not sufficient to actually identify feasible transition trajectories due to the complexity of social systems. In order to understand real life processes of possible co-evolution between society and technology, we need experimental spaces at the nexus of social and technological change where "configurations that work" can actually be tried out. Foresight needs to extend the notion of "structured stakeholder dialogue" towards "collective experimentation" (Joly et al. 2010) and link up with appropriate instruments, such as transition and strategic niche management (Kemp et al. 2007), as already practised in the realm of sustainability transition. Methods from fields like participatory design (Buur and Matthews 2008; Jegou

and Liebermann 2003; Jegou and Vincent 2009), lead user approaches (Herstatt and von Hippl 1992), behavioural economics and agent-based modelling may well have a role to play. Enabling spaces for this type of experimental Foresight processes and collective solution-seeking, such as within innovation camps or living labs, may become just as crucial for the competitiveness of innovation systems as e.g. incubators and Fraunhofer Institutes.

Yet there is no Foresight process which fully reflects all these requirements. Still, several recent Foresight processes aiming to underpin challenge-oriented policy strategies show one or more of the above mentioned characteristics:

The Netherlands Horizon Scan proposed priorities that are clearly socio-technical. Instead of settling on specific technologies, open value debates were initiated, such as "understanding what the 'greying' of society really means" or "trans-disciplinary research on issues of changing human nature and societal responses in the face of medico-technical research". The process drew on imaginative methods with one of the key results being presented in the form of a prime minister's speech. It was fully open to the citizens and used card games to foster wide public debate. A similar approach was adopted by the Danish Forsk2015[8] Foresight exercise in Denmark which resulted in complex holistic priorities such as "health and well-being of animals and people and at the interaction of bio-production with, and impacts on, the surrounding society, environment and biological diversity". Other Foresight processes such as the Poland 2020[9], France 2025[10] and the Ireland 2025[11] exercises allowed for extensive exploration of social change as well as value deliberations. Finally, the German "BMBF Foresight Process" set out from a more classical technology push approach, but ended up linking emerging technologies with changing societal patterns in priority fields, such as "production consumption 2.0, human-technology cooperation" (Cuhls et al. 2009). In the follow-up process, the ministry explicitly emphasised an in-depth exploration of demand patterns and research in social sciences and humanities.

11.7 Conclusions

The trend of the increasingly acknowledged need of innovation policy to respond to the Grand Challenges of our time was the starting point of our thoughts. Today's challenges are defined as societal and environmental tasks and are perceived to trigger a normative turn in innovation policy, which is evolving into a major rationale for policy, besides economic growth and competitiveness. This new mission orientation, however, harbours several challenges in its own right: What are the implications of this normative turn in innovation policy for research and innovation? Is the heuristic

8 The follow-up process Research2020 focuses on socio-economic challenges, online: http://en.fi.dk/research/research2015-and-research2020/research2015 (accessed 4 May 2012).

9 Bendyk (2009).

10 Online: http://www.strategie.gouv.fr/article.php3?id_article=811 (accessed 4 May 2012).

11 Online: Sharing our Future: Ireland 2025 – Strategic Policy requirements for Enterprise Development, online: www.forfas.ie/media/forfas090713_sharing_our_future.pdf (accessed 4 May 2012).

of the innovation system approach able to incorporate normative orientation? What kind of policy instruments are needed to address those challenges? We have focused our conceptual thoughts in this article on this last question and discussed in particular whether current systemic innovation policy instruments are suited to implement a strategically oriented innovation policy.

Firstly, the normative turn creates new uncertainties, such as the need for researchers and innovators to define the contribution of their research to the Grand Challenges orientation. In the light of such challenge-oriented research, the importance of curiosity-driven research is a meaningful caveat, and a good balance has yet to be found. This "normative turn", however, implies more. Findings from innovation studies indicate that addressing the Grand Challenges requires a different type of research and innovation projects altogether. "Transformative innovation" is characterised by the following aspects: socio-technical, systemic, transition oriented, experimental, glocal, transdisciplinary and participatory.

Secondly, with all the refined understanding of innovation systems, the instruments derived from the innovation system approach are mainly directed at enhancing the innovation ecosystem in order to strengthen innovation capability. So far, there is no attempt to build on the innovation system heuristic in order to modulate innovation journeys towards certain desirable objectives yet. So whereas system failure seems to be addressed by the system heuristic, "orientation failure" still remains untackled.

Accordingly, we propose that the innovation system approaches should draw on an orientation function as an integral element, in order to optimise innovation capability along the Grand Challenges orientation. The analytical and theoretical implications of national innovation systems analysis need to be widened from "only" research and innovation to socio-technical solution-seeking and therefore capture social and technological innovation equally. Specifically, approaches that focus on technologies like the technological innovation system concept therefore seem less suitable to inform open, challenge-oriented learning processes where a wide range of solutions, including non-technical ones, is taken into consideration. Particularly the active role of society as an innovative collective actor instead of simply "consumers and/or users" should be recognised.

Besides this consideration, we also see the need to further reflect on the potential and strength of "whole-of-government" policies. One prominent attempt in this regard is the German High-tech Strategy. The synergies that such a programmatic strategy can convey still need to be fostered in a more systemic manner. This statement also calls for the demand to further identify and analyse the "must-have" features of political programmes and policy instruments in order to qualify as strategic measures at all. In our view, "strategic" means more than simply goal-oriented and focused on the future. With regards to programmatic strategies like the High-tech Strategy, the term also implies a cross-ministerial, systemic effort at solution-seeking along the identified challenges.

Thirdly, based on these thoughts, we put forward some ideas and two illustrative examples of how systemic policy instruments would need to be further refined in

order to address the strategic orientation of the system. The example of participatory evaluation shows how this systemic instrument could be complemented with the analysis of new impact types or behavioural additionality to account for a normative orientation of the policy programme considered. Similarly, foresight processes that explore innovation journeys in a holistic manner are a suitable orientation instrument.

More generally, these two examples indicate some common features which might apply to the question of how systemic instruments would need to be refined to address challenge orientation: They point out the value of participation and dialogue which, however, should not be restricted to stakeholders only, but reach out to society. Furthermore, technological aspects of innovation will need to be accompanied by societal aspects, meaning social impacts and transitions, or respectively, social innovations. Our considerations show the need to develop new methods, e.g. to measure new impact types or to mobilise and rethink beliefs, tacit assessments, emotions or behavioural patterns.

To sum up, we have suggested some straightforward, but as yet missing links for strategic and systemic policy-making. In particular, the examples of participatory evaluation and foresight have shown that it is not necessary to invent new policy instruments to address orientation failure; instead we should exploit the full potential of existing systemic instruments. This may lead the way to implementing strategic policy-making, which for us is still a research desideratum in itself.

11.8 References

Arnold, E. and Guy, K. (1997): *Technology Diffusion Programmes and the Challenge for Evaluation*, OECD Proceedings, Policy Evaluation in Innovation and Technology. Towards Best Practice. Paris: OECD.

Bemelmans-Videc, M.-L., Rist, R.C. and Vedung, E. (2007): *Carrots, sticks and sermons: policy instruments and their evaluation*. New Brunswick: Transaction Publishers.

Bendyk, E. (2009): *Poland 2020. A Look from the Future. Alternative Visions of Poland's development based on the National Foresight Programme Poland 2020 scenarios*. Online: http://www.nauka.gov.pl/fileadmin/user_upload/Nauka/Polityka_naukowa_panstwa/Prognozy_rozwoju/20100104_Look_from_the_Future_wersja_wydrukowana.pdf (accessed 4 May 2012).

Benkler, Y. (2006): *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven: Yale University Press.

Boekholt, P. (2010): The evolution of innovation paradigms and their Influence on research, technological development and innovation policy instruments. In: Smits, R., Kuhlmann, S. and Shapira, P. (Eds.): *The Theory and Practice of Innovation Policy*. Cheltenham: Edward Elgar, 333–359.

Borrás, S. (2009): The Widening and Deeping of Innovation Policy: What Conditions Provide for Effective Governance? (= Circle Working Paper No. 2). Lund: CIRCLE, Lund University.

Braczyk, H.-J., Cooke, P.N. and Heidenreich, M. (1998): *Regional Innovation Systems: The role of Governance in a Globalised World*. London: VCL Press.

Braun, D. (2008): Organising the Political Coordination of Knowledge and Innovation Policies. *Science and Public Policy*, 35, 227–239.

Buur, J. and Matthews, B. (2008): Participatory Innovation. *International Journal of Innovation Management*, 12, 255–273.

Carlsson, B. and Stankiewicz, R. (1995): On the nature, function and composition of technological systems. In: Carlsson, B. (Ed.): *Technological Systems and Economic Performance: The Case of Factory Automation*. Dordrecht: Kluwer Academic Publishers, 21–57.

Chaminade, C. and Edquist, C. (2006): Industrial Policy from a systems-of innovation perspective, in EIB Papers An Industrial Policy for Europe? Context and Concepts, Volume 11, No. 1, 108–134. Online: http://www.eib.org/attachments/efs/eibpapers/eibpapers_2006_v11_n01_en.pdf (accessed 20 April 2012).

Chesbrough, H.W. (2006): *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.

Cuhls, K., Beyer-Kutzner, A., Ganz, W. and Warnke, P. (2009): The methodology combination of a national foresight process in Germany. *Technological Forecasting & Social Change*, 76, 1187-1119.

Da Costa, O., Warnke, P., Cagnin, C. and Scapolo, F. (2008): The impact of foresight on policy-making: insights from the FORLEARN mutual learning process. *Technology Analysis & Strategic Management*, 20, 369-387.

Edler, J. (2010): Demand based innovation policy. In: Smits, R., Kuhlmann, S. and Shapira, P. (Eds.): *The Theory and Practice of Innovation Policy*. Cheltenham: Edward Elgar, 275–303.

Edler, J., Cunningham, P., Gök, A., Rigby, J., Amanatidou, E., Garefi, I., Bührer, S., Dinges, M., Daimer, S., Dinges, M., Berger, M., Schmidmayer, J. and Guy, K. (2010): *INNO-Appraisal – Perspectives on Evaluation and Monitoring*, Final Report. Brussels.

Edquist, C. (2005): Systems of Innovation. Perspectives and Challenges. In: Fagerberg, J., Mowery, D.C. and Nelson, R.R. (Eds.): *The Oxford Handbook of Innovation*. New York: Oxford University Press.

Fahrenkrog, G., Plot, W., Rojo, J., Tübke, A. and Zinöcker, K. (Eds.) (2002): *RTD Evaluation Tool-box. Assessing the Socio-Economic Impact of RTD-Policies*, IPTS Technical Report Series, EUR 20382 EN. Seville.

Freeman, C. (1987): *Technology Policy and Economic Performance: Lessons from Japan*. London: Continuum International Publishing.

Gassler, H., Polt, W. and Rammer, C. (2006): Schwerpunktsetzungen in der Forschungs- und Technologiepolitik – eine Analyse der Paradigmenwechsel seit 1945. *Österreichische Zeitschrift für Politikwissenschaft*, 35 (1), 7–23.

Gault, F. (2010): *Innovation strategies for a global economy*. Cheltenham: Edward Elgar.

Gok, A. (2010): An Evolutionary Approach to Innovation Policy Evaluation: Be Behavioural Additionality and Organisational Routines, Thesis submitted to the University of Manchester.

Herstatt, C. and Von Hippel, E. (1992): From Experience: Developing New Product Concepts Via the Lead User Method: A Case Study in a "Low Tech" Field. *Journal of Product Innovation Management*, 9, 213–221.

Howe, J. (2006): The Rise of Crowdsourcing. Wired, 14, accessed November 2009.

Hufnagl, M. (2010): *Dimensionen von Policy-Instrumenten – eine Systematik am Beispiel Innovationspolitik*. Stuttgart: Fraunhofer Verlag.

Hulme, M. (2009): *Why we disagree about climate change. Understanding Controversy, Inaction and Opportunity*. Cambridge: Cambridge University Press.

Jégou, F. and Liebermann, J. (2003): Participatory Scenario Building. In: Manzini, E. and Jégou, F. (Eds.): *Sustainable Everyday, scenarios of urban life*. Milan: Edizione Ambiente. 246–255.

Jégou, F. and Vincent, S. (2009): Co-design approaches for early phases of augmented environments. In: Lahlou, S. (Ed.): *Designing User Friendly Augmented Work Environments – From Meeting Rooms to Digital Collaborative Spaces*. London: Springer, 159–189.

Joly, P.-B., Rip, A. and Callon, M. (2010): Re-Inventing Innovation. In: Arentsen, M.J., Van Rossum, W. and Steenge, A.E. (Eds.): *Governance of Innovation: Firms, Clusters and Institutions in a Changing Setting*. Cheltenham: Edward Elgar, 19–32.

Kemp, R., Loorbach, D. and Rotmans, J. (2007): Transition management as a model for managing processes of co-evolution towards sustainable development. *International Journal of Sustainable Development and World Ecology*, 14, 78–91.

Kemp, R. and Rotmans, J. (2009): Transitioning Policy: co-production of a new strategic framework for energy innovation policy in the Netherlands. *Policy Science*, 42, 303–322.

Kim, W.C. and Mauborgne, R. (1999): Strategy, Value Innovation, and the Knowledge Economy. *MIT Sloan Management Review*, 78, 129–141.

Könnölä, T., Brummer, V. and Salo, A. (2007): Diversity in foresight: Insights from the fostering of innovation ideas. *Technological Forecasting and Social Change*, 74, 608–626.

Kuhlmann, S. (2002): Evaluation as a source of strategic intelligence. In: Shapira, P. and Kuhlmann, S. (Eds.): *Learning from Science and Technology Policy Evaluation: Experiences from the United States and Europe*. Cheltenham: Edward Elgar.

Kuhlmann, S., Shapira, P. and Smits, R. (2010): Introduction. A systemic perspective: the innovation policy dance. In: Smits, R., Kuhlmann, S. and Shapira, P. (Eds.): *The Theory and Practice of Innovation Policy*. Cheltenham: Edward Elgar, 1–25.

Loorbach, D. (2010): Transition Management for Sustainable Development: a Prescriptive, Complexity-Based Governance Framework. *Governance*, 23, 161–183.

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

Malerba, F. (2002): Sectoral systems of innovation and production. *Research Policy*, 31, 247–264.

Martin, B. and Johnston, R. (1999): Technology Foresight for Wiring up the National Innovation System. Experiences in Britain, Australia, and New Zealand. *Technological Forecasting and Social Change*, 60, 37–54.

Miles, I. (2005): *Innovation in Services*. New York: Oxford University Press.

Miles, I. and Cunningham, P. (2005): *Smart Innovation: A Practical Guide to Evaluating Innovation Programmes*, A Study for DG Enterprise and Industry, October 2005. Brussels: European Commission.

Miller, R. (2007): Futures literacy: A hybrid strategic scenario method. *Futures*, 39, 341–362.

Miller, R., Shapiro, H. and Hilding-Hamann, K.H. (2008): *School's Over: Learning Spaces in Europe in 2020: An Imagining Exercise on the Future of Learning*. Sevilla.

Mulgan, G., Ali, R., Halkett, R. and Sanders, B. (2007): In and out of sync. The challenge of growing social innovations. Online: http://socialinnovationexchange.org/ideas-and-inspiration/context/features/and-out-sync-challenge-growing-social-innovations (accessed 4 May 2012).

Nelson, R.R. and Rosenberg, N. (1993): Technical Innovation and National Systems. In: Nelson, R.R. (Ed.): *National Systems of Innovation: A Comparative Study*. Oxford: Oxford University Press, 3–23.

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

Reichwald, R. and Piller, F. (2006): *Interaktive Wertschöpfung: Open Innovation, Individualisierung und neue Formen der Arbeitsteilung*. Wiesbaden: Gabler.

Salo, A. and Cuhls, K. (2003): *Technology Foresight – Past and Future. Journal of Forecasting*, 22, 79–82.

Schirrmeister, E. and Warnke, P. (2012): Envisioning structural transformation. Lessons from a Foresight project on the Future of Innovation. *Technological Forecasting and Social Change*, (forthcoming).

Schot, J. and Rip, A. (1996): The past and future of constructive technology assessment. Technological Forecasting and Social Change, 54, 251–268.

Shapira, P., Smits, R. and Kuhlmann, S. (2010): An Outlook on Innovation Policy, Theory and Practice. In: Smits, R., Kuhlmann, S. and Shapira, P. (Eds.): *The Theory and Practice of Innovation Policy*. Cheltenham: Edward Elgar, 449–466.

Smith, K. (2000): Innovation as a Systemic Phenomenon: Rethinking the Role of Policy. *Enterprise & Innovation Management Studies*, 1, 73–102.

Smits, R. and Kuhlmann, S. (2004): The rise of systemic instruments in innovation policy 79. *International Journal of Foresight and Innovation Policy*, 1, 4–32.

Soete, L. (2007): From industrial to innovation policy. *Journal of Industry, Competition and Trade*, 7, 273–284.

Steward, F. (2008): Breaking boundaries. Transformative innovation for the global good, NESTA Provocation 07. Online: http://www.nesta.org.uk/library/documents/Prov%20-%20BtB%20v8.pdf (accessed 5 May 2012).

Warnke, P. (2012): Towards Transformative Innovation Priorities, EFP Brief No. 211. Online: http://www.foresight-platform.eu/ (accessed 4 May 2012).

Warnke, P. and Heimeriks, G. (2008): Technology Foresight as Innovation Policy Instrument: Learning from Science and Technology Studies. In: Cagnin, C., Keenan, M., Johnston, R., Scapolo, F. and Barre, R. (Eds.): *Future-Oriented Technology Analysis. Strategic Intelligence for an Innovative Economy*. London: Springer, 71–87.

WBGU (2011): *Welt im Wandel – Gesellschaftsvertrag für eine Große Transformation*. Berlin: Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (WBGU). Online: http://www.wbgu.de/fileadmin/templates/dateien/veroeffentlichungen/hauptgutachten/jg2011/wbgu_jg2011.pdf.

Wieczorek, A. and Hekkert, M.P. (2012): Systemic Instruments for systemic innovation problems: a framework for policy makers and innovation scholars. *Science and Public Policy*, 39, 74–87.

Woolthuis, R.K., Lankhuizen, M. and Gilsing, V. (2005): A System Failure Framework for Innovation Policy Design. *Technovation*, 25, 609–619.