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New narratives for innovation

Roger Strand [a, c, *], Andrea Saltelli [a, b, c], Mario Giampietro [b, c, d], Kjetil Rommetveit [a], Silvio Funtowicz [a]

[a] Centre for the Study of the Sciences and the Humanities, University of Bergen, Norway
[b] Institute of Environmental Science and Technology, Autonomous University of Barcelona, Spain
[c] European Centre for Governance in Complexity, Barcelona, Spain
[d] ICREA, Catalan Institution for Research and Advanced Studies, Spain

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ABSTRACT

Sociotechnical imaginaries are visions of desired social and technological futures created and sustained by stakeholders in science, industry and politics. Within the dominating innovation narratives there are a number of implicit and explicit beliefs that are both descriptive and normative. Technological optimism is the prevailing discourse, challenged by alternative imaginaries, among them a narrative of degrowth. In this paper we argue for the importance of producing more democratic and sustainable imaginations of future social and technological trajectories. We indicate how new narratives for innovation may include different perspectives and sources of knowledge, including heterodox economics, bio-economics, science and technology studies, and Post-Normal Science. The replacement of policy narratives, however, is not achieved through science speaking truth to power. If that were the case, policies would have changed a long time ago. The present analysis and discussion illustrates how the challenge of replacement is itself one that calls for a reflexive understanding of the relationship between knowledge, belief and agency in complex research and innovation (R&I) systems.

1. Introduction: the role of imagination in the governance of science and technology

Most, if not all large-scale policy issues in modern societies are entangled into the governance of science and technology (S&T). Technologies are developed, applied or abandoned for a variety of socio-political and economic reasons, and with a range of socio-ecological impacts. Scientific fields and experts are chosen as legitimation instruments for political decisions, which recursively justifies research and innovation policies that strengthen these fields of expertise. The S&T sector and the modern state reciprocally justify and support each other in what has been called a figure of double legitimation (Lyotard, 1979 [1984]: 8). Scientised knowledge and social order are deeply interwoven in the fabric of modern societies (Shapin and Schaffer, 1985: 15).

The S&T sector is particularly hard to govern because its purpose is to create new intellectual and material objects. Prior to discovery/development, there can be no historical record of their exact properties and performance. Governance of S&T is accordingly ridden with uncertainty and complexity. If decisions are based in prior experience, genuine novelty will lead to surprises. When decisions are based on the intended functions and purposes of the desired innovations, surprises may come as collateral effects, in particular due to complex and unpredictable interactions between knowledge, technology, society and ecosystems (Collingridge, 1980; Allenby and Sarewitz, 2011). As noted by Ravetz (1986) in its discussion of “socially constructed ignorance” innovation is one area where science may generate – rather than reduce – uncertainty.

Governance of S&T can accordingly not achieve precise prediction and control. It is better characterized as an activity immersed in uncertainty and indeterminacy in which guesswork, imagination and creative thought play important roles. Science, technology and socio-ecological systems are co-produced (Jasanoff, 2004). We shall return to this point towards the end of this think piece as it has profound implications for governance and notably for concepts of risk and responsibility (Funtowicz and Strand, 2011).

The concept of sociotechnical imaginaries can be useful for understanding the creative aspect of governance of S&T. Jasanoff

* Corresponding author. Centre for the Study of the Sciences and the Humanities, University of Bergen, P. O. Box 7805, N-5020 Bergen, Norway.
E-mail address: roger.strand@uib.no (R. Strand).

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and Kim (2013) defined (national) sociotechnical imaginaries as "collectively imagined forms of social life and social order reflected in the design and fulfilment of nation-specific scientific and/or technological projects" (p. 120). While "sociotechnical imaginary" is a critical concept it should be not seen as a derogatory term. Imagination in governance of S&T should not be dismissed as merely a poor substitute for reliable knowledge. The point is not to try to predict the future but to construct it by first imagining it and then instantiate (reify) the idea:

> The concept of sociotechnical imaginaries builds in part on the growing recognition that the capacity to imagine futures is a crucial constitutive element in social and political life. Imagination is no longer seen as mere fantasy or illusion, but as an important cultural resource that enables new forms of life by projecting positive goals and seeking to attain them. Nor is imagination understood as simply residing in individual minds in the form of aesthetic considerations. Rather, imagination helps produce systems of meaning that enable collective interpretations of social reality; it forms the basis for a shared sense of belonging and attachment to a political community [...]. In short, imagination, viewed as "an organized field of social practices," serves as a key ingredient in making social order. (Jasanoff and Kim, 2013, p. 122; in-line references have been omitted for readability)

This is also why S&T governance and R&I policy work are creative enterprises. However, the dominating innovation narratives can be seen to adhere to a number of beliefs that are in part descriptive, in part normative, in part explicit, in part implicit. These include:

- The linear model: Investment in basic science leads to technological innovation which leads to industrial and economic growth. OR alternatively, a modification of the linear model, in which the emphasis on basic research and researchers' independence is replaced by a techno-science paradigm, e.g. "triple helix", whereby "the potential for innovation and economic development in a Knowledge Society lies in a more prominent role for the university and in the hybridisation of elements from university, industry and government to generate new institutional and social formats for the production, transfer and application of knowledge[1]".
- Technological innovation and change lead to more societal benefit than harm and risk.
- Innovation leads to more and better paid jobs.
- Higher efficiency in technical systems implies decreased use of natural resources and is therefore sustainable.
- Different types of capital (including natural and social capital) are equivalent and can be substituted by each other on a monetary scale.
- The main role of citizens is to be producers, consumers, receivers of welfare, voters and subjects of governance.

Hardly any serious person will defend openly the full set of these views. Indeed, they are ideological in nature and in part empirically refuted. While the master narrative of innovation for growth currently prevails in many countries and international organisations, no particular visions of future scientific, technological and social orders can be deduced or dictated from it. It does not say whether one should focus on agroecology or biotechnology; on the societal challenges of demographic transitions or those of climate change; on solar cells or shale gas fracking.

2. The master narrative of innovation for growth and its related socio-technical imaginaries

We shall only briefly rehearse the stereotypical master narrative of innovation for growth. Its main components are a set of partly normative, partly theoretical, and sometimes empirical, claims for the benefits of S&T development, innovation and growth, such as:

- Technological change in general leads to more societal benefit than harm and risk (technological optimism).
- Technological change is inevitable when scientific discoveries have made it possible (technological determinism).
- S&T development produces innovations which in turn give rise to economic growth, economic prosperity (at some level) and the creation of jobs, and this is a good in itself (productivism).
- The harmful collaterals of technological change can be efficiently dealt with by risk assessment and management, regulation, technological refinement and remediating technologies.
- Most of the above are further sustained by international competitive fears of lagging behind other countries or regions: "if we don't do it, the Chinese/Americans/Japanese will do it".

The narrative typically also includes empirical claims about how this can be achieved, such as:

- Invention is needed for innovation.
- Faster innovation leads to more and better paid jobs. Accordingly, innovation rates are good policy indicators.
- Investment in basic science leads to technological innovation which leads to industrial and economic growth (linear model) or alternatively, a modification of the linear model, in which the emphasis on basic research and researchers' independence is replaced by a techno-science in an university-industry-government policy paradigm (e.g. "triple helix", Etzkowitz, 1993).

The more normative of these claims, such as technological optimism, can be seen as ideological commitments. As such, they are not readily dismissed by their proponents upon exposure to empirical counter-evidence. Rather, one should expect disagreement also on quality criteria for evidence, incommensurability and partial breakdown of communicative discourse. This experience should be familiar to anyone who has engaged in debate with strong proponents (or opponents) of technological optimism and productivism. The more empirical of these claims are controversial at best. Technological determinism has been refuted time and again in STS (science and technology studies) research. The linear model has been declared empirically inadequate more than often, and not even Schumpeter considered invention to be necessary for innovation (Godin, 2006). The links between innovation policies and innovation rates; innovation rates and job creation; and innovation and competitiveness are all empirically questionable (Reinert, 1995, 2008; Chorafakis and Pontikakis, 2011; Sachs and Kotlikoff, 2012; Brynjolfsson and McAfee, 2014). Still, such beliefs are ubiquitously found in research and innovation policies also at the beginning of the 21st century.

Within this narrative, the metaphor of Vannevar Bush (1945) of science as the "endless frontier" was both forceful and indicative. In his report, Bush assumed that economic prosperity could only be sustained by continued and expanding consumption, which again depended on the presence of ever new products (so that consumers were not bored). The West having been conquered, the world map being complete and colonialism coming to an end, new products

[1] http://triplehelix.stanford.edu/3helix_concept.

would need to come from other frontiers than the geographical ones on Earth. Bush' conclusion was that science should, and could, provide that frontier: That new products could emerge as material objects that reify knowledge of the invisible spaces made accessible by the sciences. Chemistry and physics promised internalisation of the micro-cosmos into the economy with nuclear power and electronics. Later in the 20th century, with the development of molecular biology and genetic engineering, biotechnology gained prominence (at least in terms of this imaginary) and promised innovation based on biological material and genetic information.

Elsewhere (Rommetveit et al., 2013) we have argued how this narrative[2] with its corresponding world-view was challenged from the 1960s/70s by a number of system sciences that study Earth as a finite system (ecology, geosciences, ultimately climate science; ecological economics and bio-economics belong to this set). The idea of a finite earth, as proposed by these disciplines, including the recent diagnosis of Anthropocene (Crutzen, 2002), can be seen, at least partially, as attempts to provide different narratives. Currently one may witness attempts in R&I policy to accommodate these challenges in sociotechnical imaginaries. Some of them are based in hopes to dematerialise the economy, notably by reducing energy demands (the car industry provides interesting examples); reducing demands on scarce materials (this has been a motif in nanotechnology and biotechnology policies); or developing new goods and services that are more based in information than matter or energy. It falls outside the scope of this think piece to discuss these attempts in detail.

3. Technoscience for sustainable growth

A typical feature of the imaginaries for "sustainable growth" is that technoscience (biotechnology, nanotechnology, material science, robotics, ICT, synthetic biology, et cetera) is the main scientific ingredient in the visions of a good social life and social order. This has led to a shift in R&I policies from a focus on "generic technologies" to more emphasis on "grand societal challenges" such as climate change and transition from fossil energy sources but also migration and demographic transitions. This shift can for instance be noted in a comparison of the 7th and the 8th (Horizon 2020) framework programmes for research and innovation of the European Union. An analysis is provided by Benessia and Funtowicz (2015) who draw from original EU programmatic documents to point out some of the specificities of the imaginaries of technoscience for sustainable growth:

First, they promise Utopian wonder – technoscience will (continue to) supply modern humans with new wonderful ways of living and enjoying life. As science will continue to serve as the endless frontier the demand for sustainability on a limited planet will be met with a future expected infinite and abundant technological innovation, Secondly, the possibility of collateral or unintended effects of technological change are no longer denied but the risks are justified by the urgency of the grand challenges. We may comment that the emphasis on urgency is inherited from the system sciences and the ecological movements and then transformed into a justification for risky technological endeavours. Finally, the perspective of the Earth as a finite system is inherited and converted into the call for "smart" technology: Being finite is interpreted as (perhaps conflated with) being in principle describable and manageable by big data and systems approaches. The corresponding imaginary is one of massive measurement of everything from geophysical characteristics to individual human activity by ubiquitous sensors connected to the internet of things. The resulting big data are assembled into a comprehensive model of the Earth as a controllable physical and socio-ecological system. A particularly striking example of that vision was the FuturICT project, which was one of the final applicants for the EU "FET Flagship" R&I funding scheme that originally intended to fund two projects with one billion euros each (although it was reduced at a later stage).[3] While FuturICT did not succeed to obtain the funding, it anticipated and set out to realise "a paradigm shift, facilitating a symbiotic co-evolution of ICT and society" (see http://futurict.inn.ac/). Envisioned future geo-engineering technologies is another example that combines the system perspective with a justification by urgency (Curvelo, 2015).

4. Socio-technical imaginaries of degrowth

To identify socio-technical imaginaries of degrowth is a quite different task than for innovation for growth. There are hundreds if not thousands of policy documents that aim at innovation for growth, many of them also with some regard of sustainability and the "grand challenges" relating to the environment. By comparison, degrowth is mostly an academic-activist discourse that does not enter much into actual governance or structures of real power. It may still be worthwhile, however, to analyse how examples of degrowth statements of a more policy-like nature appear to imagine the role of science and technology in future (desirable) social life and social order. To that purpose we have chosen to present our reading of the two Degrowth Declarations from 2008 and 2010.

Canonical readings on degrowth provide powerful critiques of technological optimism and the prospects of the dematerialization of the economy, and typically search for alternatives "elsewhere" than in a technological fix (Demaria et al., 2013; Kallis et al., 2015). Still, degrowth proponents (as well as other those of other ecological movements) differ on their degree of technological optimism, their belief in the dematerialization of the economy, and their belief in technoscience as a provider of solutions (Kerschner and Ehlers, 2016; Kerschner et al., 2015). A close reading of the two Degrowth Declarations reveals two observations that may be of more general interest. Our observations are in accordance with general STS findings (Jasanoff and Kim, 2013; Welsh and Wynne, 2013) about counter-imaginaries and counter-narratives as frequently strongly shaped by the very policies against which the react and position themselves.

The first observation is that both declarations (unsurprisingly) rely heavily on what we above called systems sciences both in their description of the present and their prescriptions for and imaginations of the future. Justifications for the description of the present are sought in the validity of the system sciences, explicitly ("As the established principles of physics and ecology demonstrate […], 2008 Declaration) as well as implicitly in the choice of concepts (such as the global ecological footprint). The desirability of a future imagined world is expressed in terms of the system sciences (sustainability, equity, "right-sizing"), though not exclusively, as also other values are employed (e.g., quality of life, conviviality, self-reflection, creativity, generosity, balance, sense of community, relational goods). This finding is consistent with the picture that emerges from the canonical readings on degrowth. It is clear, however, that the imagined desirable social order is one in which

[2] In this think piece we do not separate sharply between narratives and imaginaries, but rather underline their continuity and interdependencies. Still, we might think of narratives and narrativity as sense-making about past events and experiences, whereas imagination and imaginaries of a more anticipatory kind, hence also more futures-oriented (cf. Jasanoff and Kim, 2013).

[3] http://ec.europa.eu/programmes/horizon2020/en/h2020-section/fet-flagships.

the systems sciences are not only still relevant but enjoy supreme scientific authority. We may deduce that this authority must exist also in the imagined publics of degrowth, since the process towards this future is imagined as democratic and voluntary.

The second observation is related to the first: The declarations express a high degree of substantive values. While optimistic imaginaries for technoscience typically promise wonder and better lives, they do not necessarily specify the specific values by which the lives will be improved (perhaps with the exception of longer lifespans and better health). Exactly what people will find wonderful, is to a high degree left to future people (and markets) to discover. The 2008 degrowth declaration, on the other hand, specify a number of substantive values, as mentioned above. Some of them could be discussed and replaced. For instance, the imaginary would probably still make sense without any insistence on the values of creativity, self-reflection or balance. However, the value of social and ecological sustainability cannot be sacrificed. It is constitutive both to the content and the justification of the degrowth imaginary; this can be confirmed by reading any authoritative text on degrowth, e.g. Demaria et al. (2013) or Kallis et al. (2015). The 2010 declaration makes a number of concrete suggestions, some of which are explicitly related to science and technology ("abandonment of large-scale infrastructure such as nuclear plants, dams, incinerators, high-speed transportation; conversion of car-based infrastructure to walking, biking and open common spaces"). Again, the desirability of these suggestions hinges on the normative force as well as the descriptive adequacy of the systems sciences. Desirability is to be decided by Science. Yet, in thinking about these issues one should keep in mind the normative underpinnings in early-day systems science and climate modelling: these were directly and explicitly inscribed in the universe defined by the ecology movement (Edwards, 2010). In the case of climate science, it is thus likely that these normative commitments and underpinnings were deleted as climate science became an increasingly powerful political agent, and needed to legitimate itself as "science", as distinct from "politics", in the face of increased opposition and controversy.

The Post-Normal Alternative: Taking Co-Production and Democracy Seriously in the Governance of Science and Technology.

A thorough analysis of the imaginaries indicated above is outside the scope of this think piece. First, it would require a critical appraisal of their empirical presuppositions. In the case of innovation for growth, convincing critiques are well known to the main audience of the Journal of Cleaner Production. Existing academic literature on the topic points to the imaginaries' incongruence with external constraints, notably biophysical and socio-ecological constraints. Problems of internal consistency also limit the viability of those imaginers, meaning by this their implementability in the context of the present institutions (Sorman and Giampietro, 2013).

For instance, a common R&I policy theme in many Northern countries is that advances in ICT, robotics or technoscience in general may help reduce unemployment. It often remains unclear or incomprehensible why future advances of this sort will create more jobs when past advances typically led to automatization work and a net loss of jobs (Sachs and Kotlikoff, 2012; Brynjolfsson and McAfee, 2014). As for the degrowth imaginaries, one should be able to perform a reliable examination of what should be considered as feasible and/or viable.

A challenge to the viability of the degrowth imaginary is the question how the proposed transition can be voluntary and democratic. This question is much older than the degrowth debate and also much older than the rise of environmentalist and ecological concerns. Fundamentally, it refers to the tension between two sources of legitimacy in modern societies: Science and Politics (Shapin and Schaffer, 1985). Originally, Science was conceived as having authority on facts, while political institutions, ultimately representing the People, possess the authority on what to value. Modern political theory will accordingly determine the virtues of political decisions and institutions in terms of the qualities of process and procedure. For instance, it is a commonplace that good governance entails open, inclusive and transparent processes. Innovation for growth accommodates this requirement to some extent in its neo-liberal way, allowing citizens to influence the choice of innovation pathways by consumer choice and to a lesser degree by political representation.

As noted by the fathers of the ecological movement (see e.g. Winner, 1986) this approach systematically put the citizens in the position to react to, or complain about, a technology, after – not before – this has been introduced, and demands that these reactions be framed in a context of 'risk' or 'cost versus benefits'. Political action against the innovation system per se is, however, not congruent with the innovation for growth.

Similarly, degrowth and other ecological movements may open up for democratic choice on some of the "how", but the imaginary of how to arrive and stay at a desirable future is incongruent with a true liberal democracy in which citizens may hold any set of substantive values. The realization of the imagined future depends either on the use of force, or, if by voluntary process, that the citizens somehow come to accept the facts and values of the systems sciences and the ecological movement. In fact, the challenge is greater than in the case of innovation for growth, because the "goodness" of any future social order or aspect of social life would ultimately be a question of its impact on sustainability and equity. A lot of effort has been made by political theorists to try to resolve these tensions theoretically and find models that can combine substantive global concerns with liberal democracy.

Fortunately, the tensions are more theoretical than practical. A more reflexive understanding of the degrowth movement is that it might have a positive impact exactly because it does not arrive at power. The main utility of the perspective might be as one corrective voice in the polyphony of governance that nevertheless is dominated by the innovation for growth narrative.

This does not absolve degrowth or other ecological movements from responsibility. As noted above, insistence on urgency, albeit based in sincere ecological concerns, may be taken up by the dominating narrative and translated into the need for less precaution in technoscientific innovation, as with the push for dubious policies on climate change and geoengineering (Rommetveit et al., 2010). Paradoxically, exactly because systems science knowledge does not automatically translate into technology in the way that technoscience does, its application requires more social, technical and political creativity and its impacts may be even more unpredictable and uncertain. Reflexivity is therefore also to be called for within the systems sciences.

The theoretical framework of post-normal science offers an alternative strategy for how to cope with the tensions and paradoxes of the governance of science and technology under the challenge of sustainability (Funtowicz and Ravetz, 1993; Funtowicz and Strand, 2007; Benessia et al., 2012). In particular, post-normal science may have two insights to offer. First, facts and values are not independent from each other, which means that there can be no absolute demarcation between science and politics. This insight has a number of ramifications. Epistemic communities (Haas, 1992), that is, communities of scientists who also make an effort to play a role in governance and political life, are characterized by shared descriptive and normative beliefs, and there is no simple way of disentangling the descriptive from the normative. It may appear unappealing to admit this, as one may think that whatever little authority one may get, depends on the status as the bearer of objective, value-free and certain knowledge. As should be clear from the case of climate change, however, claims to value-free certainty are ineffective in the real world when stakes are high and anyone, expert or lay, recognises the complexity of the issue (Rommetveit et al., 2010). Another option is therefore to admit and state one's values. This way of thinking is quite explicit in academic degrowth literature, e.g. in Kallis et al. (2015) and D'Alisa and Kallis (2015). Indeed, if we read the degrowth declarations as value statements, as proposals for ecological concerns, conviviality, sense of community, et cetera – as value propositions to be discussed and deliberated upon by the public – we would largely support them. The problem arises only when they are presented with a claim to scientific authority that aims to exclude or nullify other perspectives with other facts-values. A more reflexive understanding of one's own expert-activist role would suggest a more modest and humble attitude towards what can be learned in process of deliberation and democracy. Perhaps one's own substantive values were not the most important ones after all (Strand and Cañellas-Boltà, 2006).

The second insight from post-normal science is that when the illusion of absolute demarcation between science and the rest of society is rejected, one can discover new opportunities for how develop narratives, imaginaries and *praxis* of and for a desirable future. Artists, local farmers, indigenous people, city dwellers, even animals – learning and opportunities for coproduction for sustainability can be sought everywhere (Benessia et al., 2012). We have previously suggested the concept of deep innovation for innovation processes that go beyond S&T-based consumer products and aim for new solutions to socio-ecological challenges by transdisciplinary, expert-lay collaborations (Rommetveit et al., 2013). New narratives for innovation would accordingly also have to change and increase the scope of the innovation concept itself, beyond technology, into cultural and institutional change (Stirling, 2015), and indeed social life and social order.

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