Chapter 2
Reimagining Innovation

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Abstract Innovation is presented as *the* solution to address grand societal challenges. Taking this new policy motto seriously requires to renew the dominant imaginary of innovation defined by a series of attributes—technology centeredness, market relatedness, competition, entrepreneurialism, diffusion, exclusivity and creative destruction—and above all by the belief that innovation is always good. To contribute to such an endeavour, this paper starts with the discussion of five innovation myths. This discussion of deep rooted beliefs that condition a narrow understanding of innovation and innovation policies is crucial for reimagining innovation. The presentation of three literature streams (Democratising innovation, Responsible innovation, Transformative change) that currently feed the innovation renewal allows consideration of explorations in academia as well as in public policy. A re-imagination and re-invention of innovation is underway, and this dynamic is constituted of different actors from different traditions but still has some limitations.

2.1 Introduction

In 1932, in the wake of the great depression, a New York real estate broker, Bernard London, published his essay *Ending the Depression Through Planned Obsolescence* which introduced the concept of 'planned obsolescence'.

> People generally, in a frightened and hysterical mood, are using everything that they own longer than was their custom before the depression. In the earlier period of prosperity, the American people did not wait until the last possible bit of use had been extracted from every commodity. They replaced old articles with new for reasons of fashion and up-to-datedness. They gave up old homes and old automobiles long before they were worn out, merely because they were obsolete. Perhaps, prior to the panic, people were too extravagant; if so, they have now gone to the other extreme and have become retrenchment-mad. People everywhere are today disobeying the law of obsolescence. They are using their old cars, their old tires, their old radios and their old clothing much longer than statisticians had expected.

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As a solution to the economic crisis, London recommended that government should apply management and planning to undoing obsolete jobs from the past. Government should "assign a lease of life to shoes and homes and machines, to all products of manufacture (…) when they are first created." After their allotted time has expired, these things will legally be "dead" and would be controlled and destroyed in the case of widespread unemployment (Slade 2009). London's idea of planned obsolescence has become common practice. However, currently, government rules and controls are not needed; obsolescence is constructed technically through a set of practical elements that artificially reduce product lifetimes. The example of smartphones—with Apple taken to court accused of reducing the technical capacity of older versions of its star product, the iPhone—is a mere drop in the ocean. The practice of planned obsolescence has become widespread in the consumer society where innovation is considered as always good. However, the limitations of our planet are forcing us to consider seriously the damage wrought by an economic system based on planned obsolescence, and to challenge the underpinning socio-technical logic. Innovation does not systematically result in creative destruction. It can, contrary to Schumpeter's central thesis, be a destructive creation (Soete 2013).

Such reflections are crucial in an age when innovation is seen as *the* solution to major challenges such as climate change, world food security, natural resources depletion, an ageing society, etc. Hence, this paper's main objective is to reflect critically on the concept of innovation and to contribute to its reimagination.

This paper continues a research stream that originated many years earlier on the way innovation is understood, and on the shortcomings of current innovation policies. In a recent paper (Joly 2017), I argue that the 'master narrative' or innovation imaginary is defined by the attributes of technology centeredness, market relatedness, competition, entrepreneurialism, diffusion, exclusivity and creative destruction. I use the concepts of "models of innovation" to characterize different ways of innovating explored and experimented with by many actors. Models of innovation are conceptual frameworks that provide a stylised representation of how innovation is generated. These frameworks both describe the reality 'out there', and act as lenses to view and interpret this reality, and when shared widely they play a performative role (Joly et al. 2010). They guide how collectively, we see and order the world through its histories and its futures, and in this respect these models constitute a central part of what Sheila Jasanoff calls sociotechnical imaginaries (Jasanoff and Kim 2015). Models of innovation include not only economic impact and competitiveness but also the distribution of power and agency, collective learning, social relations, etc. They are value-laden and they embed a dimension of the social order; hence, they are also models of society. Finally, models of innovation involve not only discourses but also institutional devices, organisations, practices. The policies formulated follow these innovation models, although often unconsciously.

This paper deals with the same issues but in a different and complementary way. The aim is to explore why the understanding of innovation is associated so closely to this master narrative, and to highlight different initiatives and research streams that challenge this entrenched imaginary. First, I discuss five deeply-rooted innovation myths which are the pillars of the sociotechnical imaginaries of innovation. Critical

reflection on these myths is an important step in the questioning of this imaginary and opening up innovation. In the second part of the paper, I adopt a different perspective focused on three streams of literature offering alternative visions of innovation and innovation policies.

The problem of values is the common thread running through this paper. The main idea is that there is a strong link between the way we value the outcomes of our actions, the way we know, and the way we act. Hence, raising the problem of values, valuing and valuation (Dewey 2013) is necessary for opening up innovation.

2.2 Challenging Some Deeply-Rooted Innovation Myths

In a long term research project "The idea of innovation," devoted to the intellectual and conceptual history of innovation, Benoit Godin poses three important questions:

> First, why has innovation acquired such a central place in our society or, put differently, where precisely does the idea of innovation come from? Second, why is innovation spontaneously understood as technological innovation? Third, why is the idea of innovation often restricted to commercialized innovation? (http://www.csiic.ca/en/the-idea-of-innovation/)

My discussion of the innovation myths is in line with his second and third questions. It is aimed at identifying and debating a set of strongly entrenched beliefs that constitute the pillars of the socio-technical imaginary of innovation. Of course, there are different ways to identify and present these myths. Here, I chose to be sufficiently comprehensive to take account of the different unquestioned beliefs that anchor the imaginary of innovation. The 1st and the 5th myths are the cornerstones of the mainstream master frame. Innovation policies aim at fostering innovation, assuming that it is always good (myth 5) and that, although considered in the competitiveness frame, innovation will increase available resources for dealing with the different challenges we face (myth 1). Myths 2, 3 and 4 are more closely related with disruptive innovation policies understood as the impact of research and innovation investments that allow to create new technologies.

"Myth 1—Trickle-down innovation" allows discussion of the strong association between innovation and the competitiveness frame, and the idea that the maximisation of economic value through innovation is the solution to all kinds of problems. Market mechanisms are of course important but if innovation is to be the solution to all challenges, we need to consider other values as well as economic value, and take the multi-dimensionality and directionality of innovation seriously.

"Myth 2—The linear model of innovation" which has been much discussed in the literature. It remains fixed, and discussion of it reveals the diversity among innovation models and sources of innovation.

"Myth 3—Innovation is driven by (new) technologies" is a central belief discussed in the various contributions in this book. We would include also the obsession with novelty, and suggest the need to shift from a culture of novelty and disruption to the heuristic of continuity, recycling and incremental improvement.

"Myth 4—The technology selected is always the best" which leads me to introduce the idea of path-dependency and lock-in effects that characterize socio-technical trajectories. Socio-technical transitions constitute a major problem barely considered by innovation policy, and especially when what is at stake is the discontinuation of a socio-technical system (what we call *out*-novation).
"Myth 5—Innovation as creative destruction" is the master myth alluded to in the introduction. If we consider that innovation is not always good, there is an urgent need to reflect on technical democracy as new power/knowledge configurations.

2.2.1 Myth 1—Trickle-Down Innovation

The myth of trickle-down innovation is borrowed from the myth of trickle-down economics, i.e. the idea that what the rich enjoy today will benefit the poor tomorrow (Bozeman and Sarewitz 2011). The core assumption is that reducing taxes on businesses and high income stimulates investment in the short term, and benefits society at large in the long term. The myth of trickle-down economics is challenged by empirical evidence which shows that since the 1980s (and the implementation of neo-liberal policies that led to tax cuts for high earners) the degree of inequality has increased sharply (Piketty 2013).

The myth of trickle-down innovation refers to the belief that the creation of wealth through innovation will not only benefit the impoverished but also will solve the major societal problems, including environmental. There is a widespread belief that investment in research and innovation is the best way to address grand challenges.

The European Commission is an emblematic example of this policy discourse. Since 2010, innovation has been seen as *the* solution to major societal challenges (climate change, depletion of fossil fuel resources, ageing societies, etc.), and is expected to boost competitiveness, maintain employment and protect our social models.

> As public deficits increase and as our labor force begins to shrink, what will be the basis for Europe's future competitiveness? How will we create new growth and jobs? How will we get Europe's economy back on track? How will we tackle growing societal challenges like climate change, energy supply, the scarcity of resources and the impact of demographic changes? How will we improve health and security and sustainably provide water and high-quality, affordable food? **The only answer is innovation**, which is at the core of the Europe 2020 Strategy. (Horizon 2020, Innovation Union, emphasis added)

The strength of the trickle-down innovation myth rests on several entrenched beliefs. First, technological fix, i.e. the idea that technology will provide the solutions to the problems confronting us, and that if these solutions bring new problems (damage related to use of the new technology), further technological progress will provide new solutions. Geoengineering is a representative example of the belief that technology can address any problem we might face.

The second belief is that resources are fungible, and hence, in some way unlimited. Economic growth and wealth will provide the resources needed to produce new knowledge and new technologies to address society's problems. The fact that

Malthus's prophecy of doom has not come true reinforces the belief that technology and innovative capacity continually push back the boundaries to the planet.

The strength of this myth lies also in the fact that it does not challenge our way of life or the current distribution of resources and social relations.[1] For instance, genetically modified organisms (GMOs) have been portrayed as the solution to the food security problem whereas foresight exercises demonstrate that a shift from animal to plant protein would allow us to 'feed the world' without increasing agricultural production (Paillard et al. 2014). Similarly, geoengineering is touted as the technical solution to climate change and does not necessitate a change to our way of life.

This myth can be challenged on different premises. Dominique Pestre (2019) shows that the green economy has not led to a significant reduction in the pressure exerted by human activity on natural resources. This may be explained—inter alia—by the rebound effect, i.e. the reduction (due to behavioral or other systemic responses) in the expected gains from new technologies that enable more efficient use of resources. Also, the scientific evidence is increasingly alarming; for instance, the Alliance of World Scientists[2] "warning to humanity" signed by more than 15,000 scientists.

> To prevent widespread misery and catastrophic biodiversity loss, humanity must practice a more environmentally sustainable alternative to business as usual. This prescription was well articulated by the world's leading scientists 25 years ago, but in most respects, we have not heeded their warning. Soon it will be too late to shift course away from our failing trajectory, and time is running out. We must recognize, in our day-to-day lives and in our governing institutions, that Earth with all its life is our only home. (Ripple et al. 2017)

If we are to challenge the myth of trickle-down innovation we must learn to consider that innovation involves more than competitiveness. Innovation defined as future society in the making, goes beyond this framing. Accordingly, the value of innovation is not limited to economic value. As Stirling (2009) suggests, we need to take account of the multi-dimensionality of innovation, and hence, both its directionality and distributional effects. New generations of approaches to measuring the impact of research beyond economic impact are crucial for opening up the valuation process and hopefully, providing new instruments for implementing directionality (Bozeman and Sarewitz 2011; Joly et al. 2015).

[1] Needless to quote the U.S. president George H. W. Bush: "The American way of life is not up for negotiation".

[2] http://scientistswarning.forestry.oregonstate.edu/.

2.2.2 *Myth 2—The Linear Model of Innovation*[3]

The so-called linear model postulates that innovation starts with basic research, and is followed by applied research and development, and finally production and diffusion.[4] It defines the roles of various actors and the division of labor, and offers a diagnosis of what is happening and what should be improved. The origin of this model can be attributed to Joseph Schumpeter and Vannevar Bush (Godin 2015).[5] Schumpeter made a clear distinction between invention and innovation, two processes that correspond to different motivations, competences and norms. Entrepreneurs are innovators; they have the ability to bring radical change by designing new products, and implementing new processes of production or new organisations. They are motivated by the potential economic benefits that are conditioned by the temporary monopoly associated to their advance in the diffusion of innovation. Bush's report *Science: the Endless Frontier* (1945) also is seen as a pillar of the linear model. By pursuing research in the "purest realms of science" scientists can build the foundations for new products and processes to deliver health, full employment and military security for the nation. Hence, public funding of basic research is vital for social progress and economic growth:

> "Advances in science when put to practical use mean more jobs, higher wages, shorter hours, more abundant crops, more leisure for recreation, for study, for learning how to live the deadening drudgery which has been the burden of the common man for past ages. Advances in science will also bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited resources, and will assure means of defense against aggression" (p. 10). "Without scientific progress no amount of achievement in other directions can insure our health, prosperity, and security as a nation in the modern world" (p. 11). (V. Bush, The Endless Frontier, quoted in Godin 2006: 644)

History of technology and innovation studies have for long challenged the model of innovation from various directions. Rosenberg (1982) argues convincingly that technology is not merely the application of scientific knowledge. It is itself a body of knowledge about certain classes of events and activities.[6] In the academic milieu, innovation generally is considered an interactive process. The chain-link model proposed by Kline and Rosenberg (1986) may be seen as a kind of consensual representation. Interactions are the crucial element in the process; knowledge is diverse (scientific knowledge, technological knowledge, action knowledge, etc.); scientific

[3] This section draws on Joly (2017).

[4] Such an imaginary draws on a strong link between innovation and progress. For an inspiring discussion of this link, see Oki (2019).

[5] For an interesting challenge of the myth of the linear model, see Edgerton (2004). Against this, Sarewitz (2016) demonstrates that the linear model is not only a contemporary invention but that it has had a central place in the imaginary of scientific institutions and innovation policies since WWII.

[6] Among the various examples he gives, the discovery of thermodynamics is probably among the most emblematic: "*Sadi Carnot's remarkable accomplishment in creating the science of thermodynamics was an attempt of the attempt, a half century or so after Watt's great innovation, to understand what determined the efficiency of steam engines*" (Rosenberg 1982: 142).

knowledge very often is produced as the answer to a practical problem; technological tools and infrastructure condition the agenda of research. This emphasis on the role of interactions has lead innovation studies to broaden the analytical scope and to take account of the innovation systems in which they are embedded (Fagerberg and Verspagen 2009).

However, despite a broadening of the notion of innovation in academia, institutions responsible for innovation policy continue to tend to adopt the definition of innovation proposed in the 1960s. To illustrate the lasting influence of the linear model, one could cite the European Union's Lisbon Agenda, the objective of 3% of GDP invested in research, and the shaping of the knowledge economy. This vision has led to implicit or explicit assertions that "*Science is the solution, society the problem*". Society is expected to become more entrepreneurial, to become more accepting of and enthusiastic about new technology. It can be seen as the 21st century version of the Chicago World Exhibition's catchphrase that "society has to conform".

2.2.3 Myth 3—Innovation Is Driven by (New) Technologies

Although the definition of innovation often is broad and not limited to technological innovation (see for instance the definition in the Oslo Manual[7]), in the public arena, the term innovation generally is associated to technology. This is reflected in some of the most famous rankings of innovation, for instance Thomson Reuters which focuses on patents as a proxy for the capacity to innovate.[8] Some of these rankings have the ambition to implement a more comprehensive view, thus integrating a wide variety of sources of innovation including the human factor and entrepreneurship (see for instance, the Global Innovation Index[9]). However, the association with technology, and specifically new technologies remains very strong. It would be hard to imagine an Innovation Forum that would not stage nanotechnologies, digital technologies, big data in biology, etc.

The close association between innovation and technology is related to the technological fix discussed above. The technological solution avoids researching solutions that would imply societal changes. Also, there is a bias toward *new* technologies. The solutions will be found in new technology, not improvements to old ones. The historian of technology David Edgerton shows that this bias toward novelty is deep rooted. In *Shock of the Old* (Edgerton 2006), Edgerton demonstrates that historians of technology generally study technologies in their emergent stage and rarely look at technologies in use. Take for instance, the example of the Green Revolution. The

[7]Oslo Manual: "An innovation is the implementation of a new or significantly improved product (good or service). A product innovation is the introduction of a good or service. A process innovation is the implementation of a new or significantly improved production or delivery method." (OECD 2005).

[8]http://top100innovators.clarivate.com/content/methodology.

[9]https://www.globalinnovationindex.org/.

imaginary of the Green Revolution is associated to genetics and the diffusion of so-called high yielding varieties (HYV) which earned Norman Borlaugh his Nobel Peace Prize. However, recent research on the Green Revolution in India demonstrates that the increase in wheat production had little to do with HYV (Subramanian 2015). Rather, it was driven by rapid expansion of irrigation, facilitated not by Nehru's big dams but by small, privately-owned, traditional groundwater pumps. By highlighting the key role played by one of the oldest agricultural techniques (irrigation) in what was assumed to be a revolution based on new technologies, this research challenges the dominant view of innovation.[10]

Paying attention to technology in use, to incremental improvement and to maintenance calls for a Copernican revolution in innovation studies. It forces scholars to shift from the fascination with novelty to the heuristic of continuity (Joly 2015). Currently, a range of experiences run in this direction which materializes in the proliferation of new expressions such as: frugal innovation, grassroots innovation, reverse innovation or innovation from the bottom of the pyramid (Prahalad 2005). This goes along with a new geography (the "South" as a key source of innovation), and a new cosmology (the "users" at the core) of innovation. Hence, there is a need not only to acknowledge the non-technical sources of innovation but also to shift from a culture of novelty and disruption to a culture of incrementalism, recycling and maintenance.

2.2.4 Myth 4—The Technology Selected Is Always the Best[11]

The belief that technological competitions are, like sports competitions, processes that allow selection of "the best", is strongly anchored. Since the 1980s, the sociology of innovation, and the economics of technical change have been grounded on a very different assumption, namely that a technique is not used widely because it is intrinsically better but that it becomes the best because it is widely used.

For scholars who adopt a constructivist approach to technology (e.g. social construction of technology—SCOT, Bijker et al. 1987) the idea that technologies are not selected because they are most effective is obvious. The adoption of this idea by economists has been more difficult. Brian Arthur and Paul David, economists working at the Santa Fe Institute and Stanford University, helped to revise the myth of selection of best techniques by the market (Arthur 1989; David 1986). Studying technology competition, they show that increasing returns from adoption is a key explanation. If we assume that the efficiency of a technology is positively related to the number of users, then competition among technologies can produce surprising effects such as the exclusion of intrinsically superior techniques, or even lock-into technologies with lower intrinsic value. Under this hypothesis, competition models show that small events (Arthur) or historical accident (David) can give an initial

[10] Robert Boyer (2019) shows that innovation in healthcare is not merely determined by technological changes since it is conditioned by institutional arrangements.

[11] This section draws on Joly (2016).

advantage to one technology although it may not be intrinsically superior; cumulative effects do the rest.

Several examples are cited regularly. For instance, the QWERTY typewriter (and now computer) keyboard is a legacy of a design that took account of physical constraints (transmission by means of bars) to achieve greater efficiency which has proved impossible to displace although according to ergonomics other keyboard designs are more efficient (the CLIO keyboard seems to be the best). Another exemplar from the nuclear field is the diffusion of light water reactors despite the claim of many specialists that gas cooling would have proved more efficient if as many resources had been devoted to its development as were invested in light water reactors (Cowan 1990). The assumption of increasing returns to adoptions runs counter to the previous general assumption in economics. Increasing returns can be explained empirically by five complementary phenomena: (i) strong learning by doing; (ii) network externalities; (iii) economies of scale; (iv) informational increasing returns; and (v) technological complementarities. These features are applicable to most current and emerging technologies.

Taking account of the diversity of technological pathways is one of the important implications of this research stream. In the presence of high increasing returns, the exclusion of alternative techniques can be too rapid and too broad. It may be necessary to enact policy to incentivise the exploration of a wide range of options (Callon 1994; Stirling 2008). Also, in situations where technologies have high negative unintended effects, it may be necessary to imagine how to withdraw socio-technical elements (Goulet and Vinck 2012) which would require learning how to govern *out*novation processes.[12]

2.2.5 *Myth 5—Innovation as Creative Destruction*

Innovation as creative destruction can be considered the master myth. This myth is associated to Joseph Schumpeter who conceptualised innovation and the role of the entrepreneur as the drivers of economic development and stated forcefully that the destruction of existing elements is necessary for the creation of new ones.

> The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates.
>
> […] The opening up of new markets, foreign or domestic, and the organizational development from the craft shop and factory to such concerns as U.S. Steel illustrate the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. (Schumpeter 1942: 82–83).

That the birth of something new is conditioned by the destruction of something that exists is an old idea. Reinert and Reinert (2006) remind us that the Greeks inherited

[12] To learn more about outnovation, one can refer to the analysis of the governance of discontinuation of socio-technical systems. See the DiscGo project and the contribution of Stegmaier et al. (2014).

the myth of Phoenix from the bird Bennu in Egyptian mythology, symbolising the rising sun.

> Bennu or Phoenix was consumed to ashes, but out of the ashes grew a new Phoenix which, in time, repeated the 500 year cycle. In medieval Christian writings Phoenix was a symbol of the Resurrection of Christ, in itself a prime example of creative destruction.

The vision of creative destruction leads to a particular view of history in which the arrow of progress is associated to cyclicality. On the one hand, as with the Phoenix and its 500-year cycles, creative destruction leads to cyclical rather than linear historical patterns: take Schumpeter's 'clustering of innovations' as the basic cause of long economic (Kondratieff) cycles. On the other hand, new cycles are associated to new core technologies which are supposed to be better than the old ones. The steam engine and railroads were replaced by electricity, the internal combustion engine, oil and chemistry, which are being replaced by electronics and informatics, biotechnology, etc. New cycles bring economic and social progress (Perez 2002; Freeman and Louca 2001).

Hence, the myth of creative destruction is associated to the idea that innovation is always good. In this frame, actors who contest innovation are laggards. Against this, sociology and the history of technology show that controversies and contestations have played an important role in the innovation process (see inter alia Callon 1981; Rip 1986; Oki 2019; Pestre 2019; Fujigaki 2019). The concerns over the potential (economic, social and environmental) damage caused by new technologies led to the institutionalisation of technology assessment, first in the US with the establishment in 1972 of the Office of Technology Assessment, and then in most European countries in the 1980s and 1990s. However, de facto, technology assessment operates as a tool for improving and fostering technological change, not controlling it (Collingridge 1980; Joly 2015).

In a paper entitled "Is innovation always good?" Luc Soete, one of the leading economists of innovation, warned that contrary to mainstream beliefs, the creative part of innovation does not necessarily outweigh its destructive aspects (Soete 2013). Soete shows how innovations in consumer goods have led our societies to "a conspicuous consumption path of innovation-led 'destructive creation' growth" (Soete 2013:136).

> Easy and cheap ways in which existing usage value can be destroyed are, for example, through product design and restrictive aftermarket practices, and in the extreme case through so-called 'planned obsolescence' purposely limiting the life-span of particular consumer goods. (…) Probably the most extreme and widespread case would be new product design, for instance in fashion clothing or shoes, destroying existing output, but there are of course many other forms and sorts of restrictive aftermarket practices that can be found in many ICT-related sectors, such as software writers limiting backward compatibility, or electronic goods manufacturers ceasing to supply essential after-sales services or spare parts for older products, not to mention smart phones, mobiles, iPods, or iPads. It is actually surprising in how many areas processes of 'destructive creation' exist that hinder prolonged usage and induce customers to migrate continuously to newer models. (Soete 2013: 138)

As mentioned in the introduction to this chapter, the concept of planned obsolescence originated at the beginning of the XXth Century as a response to the economic

crisis. Historians of technology have shown how planned obsolescence became a systematic pattern in the production and consumption of goods (Slade 2009). Heinz Wisman, a French philosopher, takes an extensive view of planned obsolescence and argues that it is the result of a desire-based economy invented in the late XIXth Century, a time when innovation was decoupled from progress, and novelty became the goal (Wisman 2015). Post WWII, the making of the consumer society and the invention of marketing considerably amplified this desire-based economy at the cost of depleted natural and also psychic and cognitive resources (Cohen and Todd 2018).

Contestation of planned obsolescence is growing in the public arena. Take France as an example. The French Law on Energy Transition (Law 2015-992) introduced the crime of planned obsolescence defined as "the set of techniques by which a manufacturer aims to deliberately shorten the lifetime of a product to increase its replacement rate". In 2017, the *Halte à l'Obsolescence Programmée*—HOP or Stop Planned Obsolescence program—filed a complaint against Apple after the company admitted to intentionally slowing the operation of its iPhones as they age. HOP had already filed a legal complaint against the printer manufacturers Canon, HP, Brother and Epson, claiming that their devices forced users to change their ink cartridges before they were empty.

If we take for granted that innovation is not always good—which is itself a strong stance, what are the implications of this position? This returns us to the problem of control of technology. David Collingridge referred to the dilemma of knowledge/control: the impacts of technologies which are still flexible are unknown whereas technologies whose impacts are well known have irreversible effects (Collingridge 1980). In this perspective, diversity is crucial for limiting irreversibility. This leads to consideration of how the balance of power and the related knowledge field, might increase the capacity to act.

2.2.6 Wrap Up 1. Challenging the Myths, Reimagining Innovation

As we have shown, master narratives that frame current innovation policies are based on two key beliefs. First, following Schumpeter's concept of creative destruction, innovation is considered as always good, and second, following the idea of trickle-down economic, improving economic competitiveness is supposed to create resources for solving any types of problems. Challenging these myths leads to reconsider innovation and innovation policies. This obviously raises difficult questions such as: how to define the good directions for innovation? How to assess the innovation according to these directions and their related values? How to govern or steer processes of innovation? Such questions are now addressed in the literature under the heading 'directionality of innovation'. Obviously, taking care of the diversity and flexibility of socio-technical systems is essential. However, as innovation is

an uncertain journey (Van de Ven 2016), opening up the black box of directionality provides more questions than answers.

The discussion of innovation myths also allowed us to identify a set of complementary elements. First, we have to consider not only the results of innovation but also its process and to pay attention to the diversity of ways to innovate. This is not only a matter of efficiency but a matter of distribution of agency, dynamic of collective action, empowerment and social relations. Second, opening up innovation leads to challenge a culture of novelty and disruption. In many cases, we are confronted not to the challenge of introduction of a new idea, as traditionally meant by innovation, but to the need of discontinuing existing socio-technical systems, and hence to govern what we call *out*novation. Related to this, we have to balance the hype for novelty with a culture of maintenance, repair and recycling.

Challenging innovation myths is a good start on the reimagination path. However, the challenges are colossal. Fortunately, reimagination is under way and may be seen in the way actors reinvent new ways of innovation and scholars who explore transformations of innovation and innovation policies.

2.3 Re-inventing Innovation and Innovation Policies an Overview of Recent Re-openings

We now change perspective and consider literature streams that currently are feeding the renewal of innovation. Our analysis is centered mainly on academic works. However, this also concerns practices and public policies since strong coproduction processes are involved (Jasanoff 2004). The first strand of work "Democratizing innovation" owes much to the actors that explore and experiment with alternative ways to innovate from the centralized delegated model. It also owes much to academic research that has attracted public attention, and made local experiments transportable and generalizable to an extent.

The second and third streams involve the top down, and have close ties to European Commission initiatives, although both investigations are widespread. The "Responsible innovation" stream is related strongly to the perceived need to re-align science and society, triggered by strong contestation of new technologies. The European Commission Framework Programmes are important spaces for coproduction involving STS scholars among others. The third stream of work on "Transformative change" emerged from the strong convergence of academic research devoted to sustainable transitions, and the recasting of innovation policy around grand challenges. The appointment of Mariana Mazzucato as special advisor to Commissioner Moedas on mission driven science and innovation is an illustration of such convergence.[13]

[13] Professor of Economics at University College London, she is an advocate of the role of the State in innovation policy.

2.3.1 Democratising Innovation

The traditional view of innovation based on a strong division of labor between innovators and passive users (a centralized-delegated model of innovation) is increasingly being challenged. The literature on bottom up innovation, user centered innovation, distributed innovation, community-based innovation, etc. is burgeoning.

Eric Von Hippel, Professor of Management of Innovation at MIT, was one of the pioneers of this renewal. Working on innovation in very different areas, he demonstrated that the sources of innovation vary across situations, and that in sectors such as scientific instrumentation and semiconductors, users (usually companies rather than individuals) are the main source of innovation (Von Hippel 1988). Innovation is based on neither technology push nor demand pull; it is the result of interactions among actors with complementary knowledge. Users are no longer seen as only using; they learn by using, and in some situations they co-innovate. This means also that users learn from each other, and that innovators can learn from users. In his 1988 book, Von Hippel introduced the concept of distributed innovation. Innovation is distributed if the process is fed from various sources, for instance user-produced prototypes and experiments. Importantly, Von Hippel observed that the exploitation of this diversity is not natural but depends on the ability of firms to recognise these sources of innovation, and to develop forms of organisation and management tools to exploit them. He claimed that this has major implications for the management of innovation as well as for innovation policy (system level analysis and policy, property rights, support for users, etc.).

In his more recent *Democratizing Innovation*, Von Hippel (2004) goes beyond a firm-centric analysis to consider numerous actors, including creative communities. Distributed innovation challenges a structural feature of the social division of labour, the separation between users and consumers. Von Hippel identified two engines of distributed innovation. First, in the delegated model of innovation, standardised products are the rule. Large manufacturers design products to meet the needs of a large market segment to achieve wide diffusion and maximise turn-over and profits. Distributed innovation allows the customization of product design to respond to the diversity of user needs. Second, the contribution of users is growing as a result of continuing advances in computing and communications capabilities, and digitalisation of many areas.

The example of OSS (open source software)—and the wider development of open access information technology tools—is often used to illustrate the distributed model of innovation, and to show that one of the motives of its promoters is to redistribute agency, knowledge and power. In other words, a normative model of society is also being performed. A key feature is the invention of *collective property rights* through the creation of the general public licence (GPL or copyleft): the right to use the product at no cost, the right to modify it, and the right to distribute modified

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https://marianamazzucato.com/uncategorized/mariana-mazzucato-appointed-as-special-advisor-for-mission-driven-science-and-innovation-to-eu-commissioner-for-research-carlos-moedas/.

or unmodified versions at no cost. Even when incorporated in commercial tools, software protected by a GPL is not proprietary.

There are other examples of the role of diverse actors in distributed innovation, ranging from the involvement of patient associations in medical research (Rabeharisoa and Callon 2004), the role of users in the design of software (Pollock et al. 2016), participatory plant breeding research experiments and exchanges of experience in French 'peasant networks' (Bonneuil et al. 2006), and bottom-up innovations in low-input agriculture (Wiskerke and Van der Ploeg 2004).[14] In addition, the recent cases of the OS models of 3D printer Reprap show how technical devices (information technologies coupled with new manufacturing devices) can reinforce the capacity of individuals to make (or hack) technology. Such technological transformations have some sociological drivers as illustrated by the burgeoning of communities of makers and the opening of new sites where the creation of technology is distributed (FabLabs, Living Labs, Hackers' Spaces, etc.). In a distributed network, everyone is supposed to contribute and to learn from each other. These peer-to-peer networks are commonplace in computing and information technology. They allow communities to share information and knowledge. The implications of peer-to-peer go well beyond computer systems, and some scholars predict that in the information age it becomes the basis for a new socio-political constitution (Benkler 2006).

We can sketch the set of values associated to the stream "democratising innovation". Of course, more research is needed to ground this on strong base. Democracy is indeed a central point. However, since it is an essentially contested concept (Gallie 1955), it needs to be qualified. Looking at the literature and previous experience, I suggest that the meaning intended is strong democracy (Barber 1984) in which communities are the main drivers. This stance towards democracy is developed in Callon et al. (2009) which focuses on concerned groups. It is accompanied by the values of empowerment and autonomy. Democratising innovation runs counter to the central/delegated model of innovation. This also is related to actors' curiosity, to valuing local experience, tinkering, making and hacking (well illustrated by the Do it Yourself (DiY) movement).

2.3.2 Responsible Innovation

The issue of research responsibility is not new. On the one hand, scientific responsibility has a long history of much debate within and around the scientific community, and institutionalised forms such as ethics committees, or guidelines and rules to prevent misconduct and misbehavior. On the other hand, the expression 'responsible innovation' (Guston 2004), or related expressions such as 'responsible development', date back to the late 1990s and appeared as a response to a series of crises (the GMO

[14] For a recent comprehensive analysis of the role of users and distributed innovation, cf. Hyysalo et al. (eds.) (2016).

crisis being the most memorable) (Owen et al. 2012). In contrast, the responsible research and innovation (RRI) frame, promoted by the European Commission since 2011 is more recent.

One of the most-cited definitions comes from René von Schomberg (2011: 9), a scientific officer at the DG Research, and one of the notable promoters of the concept:

> Responsible Research and Innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).

The definition of RRI adopted in official European Commission documents reads as follows.

> The grand societal challenges that lie before us will have a far better chance of being tackled if all societal actors are fully engaged in the co-construction of innovative solutions, products and services.
>
> Responsible Research and Innovation means that societal actors work together during the whole research and innovation process in order to better align both the process and its outcomes, with the values, needs and expectations of European society. RRI is an ambitious challenge for the creation of a Research and Innovation policy driven by the needs of society and engaging all societal actors via inclusive participatory approaches. (Directorate-General for Research and Innovation 2012: 2)

Textual analysis of the RRI literature demonstrates that RRI discourses are remarkably convergent and have three distinctive features (Tancoigne et al. forthcoming). First, they are about research and innovation outputs and goals, and take serious account of the desire to *steer* research and innovation towards solving societal problems, especially so-called 'grand challenges'. Second, RRI discourse refers to inclusive and participative forms of governance which clearly differentiates it from discourses premised on scientists' self-regulation of science. Third, the meaning of responsibility embedded in RRI is prospective rather than retrospective, moral rather than legal, and collective rather than individual.

Programmatic papers by influential scholars in the field of RRI elaborate on this. According to Owen et al. (2012) there are three main features of RRI that to an extent overlap the European Commission Framework:

- Democratic governance of the purposes of research and innovation and their orientation toward the "right impacts".
- Responsiveness, emphasising the integration and institutionalisation of established approaches of anticipation, reflection and deliberation in and around research and innovation, influencing the direction of these and associated policies.
- Framing of responsibility in the context of research and innovation as collective activities with uncertain and unpredictable consequences.

According to Stilgoe et al. (2013), RRI has four dimensions: (i) anticipation, (ii) reflexivity, (iii) inclusion, and (iv) responsiveness.

The future actual impact of RRI is much discussed. The possibility of responsible washing should not be excluded since the RRI frame is voluntary and highly

flexible. It can be considered a strategic tool for maintaining corporate licenses to operate. Indeed, it needs not be taken at face value but seen as a discursive space that contributes to re-imagining innovation.

What is valued in the stream of responsible innovation is the alignment of science and society as a major lever for addressing grand challenges. This is related to the focus on new technologies and their contestation. This alignment is supposed to emerge through dialogue, anticipation and reflexivity. Responsibility is understood as care for the future which is framed as threats to be avoided. Openness is the core value.

2.3.3 Transformative Change

This third stream is also coproduced by public policy and academic research. On the policy side, the grand challenges discourse has become pervasive, both in Europe where it is a central political motto, and in other parts of the world. To address grand challenges such as climate change, world food security, natural resources depletion, ageing societies, etc. doing more of the same is no longer an option. It is necessary to do it differently, and hence, to promote deep transformations.

This echoes academic research which for more than 20 years has focused on socio-technical (sustainable) transitions (Rip and Kemp 1998; Geels 2002; Geels and Schot 2007). Drawing on the lessons from analyses that highlight the path-dependent character of technological trajectories (Cf. Myth 4—the technology selected is always the best), researchers have conceptualised transitions as dynamic processes that allow socio-technical systems to be unlocked and which re-open possibilities. Such dynamic processes are considered to be multilevel, involving a combination of transformation forces coming from the bottom (niche exploration), from the top (influence of the environment) but also from the socio-technical system itself (weakening of core technology, change in consumers' preferences, new incumbent strategies, changed expectations, etc.). This is a sketchy account of a complex and vibrant research stream but it suffices to demonstrate its core position: (i) due to strong environmental, social and economic limits, there is a need for sustainable transition; (ii) the changes are both technological and social (socio-technical); (iii) due to uncertainty, complexity and ambiguity, transitions cannot be governed by simple command and control processes.

As shown in a paper by Johan Schot and Ed Steinmueller from Science Policy Research Unit (SPRU), such a frame strongly shapes innovation and leads to the redesign of innovation policy (Schot and Steinmueller 2016). The core question is: "How to use science and technology policy for meeting social needs and addressing societal challenges?" (Schot and Steinmueller 2016: 5). In a transformative change perspective, this question leads to a focus on the way innovation policy can achieve system-wide transformation of the food, energy, material, mobility, healthcare and communication socio-technical systems. Deep transformations—not competitiveness or other targets—constitute the core objective of innovation policy. This requires

thinking far beyond the traditional innovation policy tools based on support for R&D and prioritisation of specific research avenues.

Innovation policy as a process within a transformative change perspective involves the opening up of the possibilities for system change through support from experimentations that go beyond—and often challenge—the incumbent frame.

> Innovation policy is not about setting priorities, but about improving the process of opening up to a wide range of choices (…). Innovation policy should allow for deep learning, challenges to dominant views, and nurturing a greater diversity of options. It should enable experimentation with options beyond those emerging within the narrow boundaries set by incumbent institutions (…). (Schot and Steinmueller 2016: 21)

In terms of governance, what is crucial is that transformative changes involve tensions and conflicts, and that it challenges the interests of incumbent groups often occupying dominant positions. Schot and Steinmueller consider that what are needed are new institutional arrangements and governance structures that bridge governments, markets and civil society. They suggest also, that public deliberation could shape collective expectations and strengthen commitment to the search for new solutions that might challenge current interests. In their view, transformative change involves democratising control over innovation production and diffusion.

Such a framework is tentative, and its ability to achieve its goals remains to be demonstrated. Concern over the diversity and directionality of innovation beyond the competitiveness framework—and the need to think of technical democracy as new power/knowledge configurations—are rightly pointed out. However, it probably overtrusts the ability of distributed governance systems to make such changes. Is it possible, for instance, to govern outnovation of major socio-technical trajectories such as pesticide use in agriculture? We would suggest that such changes require to consider very seriously strong asymmetries of power and resources. Hence, the weak part of the framework is the delegation to hybrid governance arrangement, which prevents consideration of the specific role of public authorities. Against this, Mazzucato (2015) suggests that it is necessary to consider this seriously, and to look at the broader implications for mission-oriented investments of not just fixing market or system failures but actively shaping and creating markets.

What is valued in the transformative change stream is the ability to govern and perform socio-technical transitions. The democratic values are important in so far that they contribute to successful unlocking of trajectories that are not sustainable. Since the emerging socio-technical systems are unknown, experimentation and technological diversity are both valued highly. Communities are not important per se but depending on whether they contribute to the needed transitions through local experimentation that potentially is generalised.

2.4 Conclusion

The dual approach developed in this paper is aimed at opening up the socio-technical imaginary in order to renew innovation. The discussion of the innovation myths is a

first important step which makes visible the deep beliefs that condition this imaginary. The presentation of the three literature streams that currently feed the innovation renewal allows consideration of explorations in academia as well as in public policy. This shows that a re-imagination and re-invention of innovation is underway, and that the dynamic is constituted of different actors from different traditions.

These three streams share a need for diversity and directionality of innovation and they do take into consideration the strong uncertainty, complexity and ambiguity of innovation journeys. They share the need for system transformation, although with some important nuances on power and politic issues. The RRI stream is in strong continuation with the current system. Needed changes rest upon awareness, deliberation and reflexivity. These are indeed possible adaptations and a future world where powerful actors adopt a wider sense of responsibility may be imagined. However, this stream does not take into account asymmetries of power and the eventual role of incumbents in the limitation of strong changes. Climate change constitutes a real- and crucial-laboratory for testing this. So far, we can observe strong limitations of the effectiveness of changes mainly based on voluntary agreements. The meaning of democracy embedded in the 'Democratising innovation' stream is close to strong democracy (Barber 1984) and related to the dynamic of local communities. In a way, this is close to the experimentation part of the 'Deep transformation' stream and this is essential for opening up and exploration. This later stream also includes the need for upscaling local experimentation, a key step for deep transformations. As mentioned above, the trust on distributed governance to perform these changes may be challenged. We definitively need more research and discussion on the organisational and political capacities needed for governing socio-technical transformations (Borras and Edler 2014) and to pursue research on technical democracy (Callon et al. 2009). This discussion also implies that reimagining innovation not only requires to challenge the innovation myths but also the socio-technical agencements they are embedded in. Considering the difficulties, the knowledge produced may be qualified as uncomfortable (Rayner 2012) and there are good reasons for it to be ignored.

Although these streams share a need for diversity and directionality of innovation, they hardly challenge the fashion for novelty. This is not surprising if we consider that as suggested in Sect. 2.1, this would mean a Copernican revolution in innovation studies. However, the shift to—or to put it more gently the balance with—a heuristic of continuity, maintenance, repair and recycling will be necessary to reconcile innovation and progress (Wisman 2015).

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