COMMENTARY

Innovation policy: not just a jumbo shrimp

Policies that predict and direct innovative research might seem to be a practical impossibility, says **David H. Guston**, but social sciences point to a solution.

Innovation policy could be seen as an oxymoron. Like an 'open secret', or 'jumbo shrimp' — which the late comedian George Carlin compared to 'military intelligence' — the words just don't go together. Innovation policy evokes a tension. How does one predict and direct something that is by nature unpredictable and, by necessity, often undirected?

The tension in innovation policy runs deeper than word play, of course. Policies are made too late to change the past that necessitated them and too early to understand the future they are meant to shape. Innovation sparks the difference between that past and future. Policies are incremental, but the goals of innovation often tend toward the revolutionary. An explicit goal of recent initiatives in nanoscience, for example, has been to usher in "the next industrial revolution"[1]. That is about as non-incremental as one could imagine, given that the transformations associated with steam power and information technology affected both industrial organization, and every aspect of social and family life, language and art, politics, warfare and more.

Innovation policy should encourage a dynamic scientific enterprise to contribute to identifiable social outcomes, such as in areas of health, energy and the environment. But research occasionally generates radical changes that are unpredictable and often not associated with those pre-defined social goals. Nations invest in research for social purposes that are often thwarted by the nature of the research process itself. For example, investment in health research may return many high-quality scientific papers, but less in terms of affordable and accessible improvements in health care. Innovation policies for nanotechnology embody these contradictions.

Research initiatives

The US National Nanotechnology Research and Development Act of 2003 authorizes a National Nanotechnology Initiative (NNI) to coordinate about US$1.5 billion in research across some two dozen agencies. Currently in revision before Congress, the act emphasizes commercialization for international competitiveness as a driving rationale on one hand, while requiring research into societal impacts on the other[2]. Interestingly, the societal research promoted by the NNI may provide ways to address the contradictions inherent to innovation policy.

The NNI has funded research to develop 'anticipatory governance'[3], which works by correcting three unspoken and ill-formed premises that underpin these contradictions.

The first of these premises is that policy is supposed to have a clear cause-and-effect relationship in society. But limiting policies to being effective instruments misses the value-laden nature of political deliberation and choice. Policies are, and should rightly be, about articulating public values[4].

Although many pieces of basic legislation contain clear articulations of public values, the NNI act announces none. A close reading of the law's text, however, reveals several guiding public values: nanoscience research should be performed with an interdisciplinary bent. It should be oriented toward improving the economic competitiveness of the United States. It should be subject to suitable administrative oversight. And it should be done in close conjunction with public engagement and societal implications research. But in part because these values must be teased out of the text, they have remained controversial or even unrecognized among the communities that implement the law.

The second premise is that policy is supposed to be grounded on a clear understanding of the natural world. We must consider both the shortcomings of our understanding of the natural world and the strengths of our understanding the social world. Among the former is that — as Danish physicist Niels Bohr reportedly said — "prediction is very difficult, especially about the future". At any given point in time, science provides both an incomplete and a changing portrayal of the natural world. In matters closely related to policy, such as climate change, it is often not the case that more data helps to make science more complete politically[5]. And even if scientists might have some monopoly over the technical knowledge in their chosen field, they have no similarly exclusive take on the vast bodies of knowledge and practice implicated in turning their discoveries into actual innovations or policy decisions.

Luckily, discarding science-based prediction as an exclusive contributor to legislative action does not disarm policy-makers. Understanding from the social world — concepts such as precaution and anticipation — can help to remove unpredictability as a roadblock. Precaution, as seen in environmental risk management, connotes acting to avoid predicted but uncertain hazards. Anticipation, in contrast, denotes building the capacity to respond to unpredicted and unpredictable risks. Many of us frequent gyms to lift weights. But we do not predict that our lives will depend on our ability to perform a 'lat pull' or a curl, or to bench-press our weight. Instead, we rightly believe that these exercises will build in our bodies a capacity to withstand whatever physical and emotional stresses we might confront. Giving up on prediction does not mean giving up on anticipation. We must exercise the various intellectual and imaginative capacities that will prepare us for the challenges that innovation will surely offer.

> "We vastly underestimate our ability to productively shape the scientific enterprise."

The third flawed premise is that ongoing and occasionally revolutionary change is inherent to the scientific enterprise. We vastly underestimate our ability to productively shape the scientific enterprise and effectively steer it. Policy-makers, their scientific advisers and their lab-bench constituents too often cling to Hungarian–British polymath Michael Polanyi's logic that "you can kill or mutilate the advance of science, [but] you cannot shape it"[6]. The scientific enterprise we have — its foci, productivity, contributions, strengths and shortcomings — is at least as attributable to the governing forces of personalities, policies, and institutions as it is to the autonomous play of researchers.

Simple solution

Anticipatory governance addresses these three shortcomings. It prescribes the explicit inclusion of values in deliberations, often through the direct engagement of various groups, including the lay public. Public engagement has been a major theme in nationally sponsored societal research programmes for nanotechnology, including the

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Nanoscale Informal Science Education (NISE) Network in the United States. Funded by the National Science Foundation, NISE aims to transform the role of science museums from informal educators of the public to conveners of public deliberation. The Center for Nanotechnology in Society (CNS) at Arizona State University in Tempe recently conducted the first-ever National Citizens' Technology Forum held in the United States. Similar public-engagement activities have also been featured in the nanotechnology policies of the European Union, United Kingdom, France and Belgium, among other locales.

Next, anticipatory governance prescribes the creation of what one might call 'anticipatory knowledge', particularly through exercises such as scenario development, to build a broad-based capacity to recognize and understand social change and its relationship to scientific and technical change. Several roadmaps elaborate the technical visions of nanotechnological futures, such as the four stages of nanotechnological development[7]. But more integrated socio-technical scenario projects have flourished, including scenario development by the Project on Emerging Nanotechnology at the Woodrow Wilson International Center for Scholars in Washington DC, the 'open-source' scenario development of the NanoFutures project by the CNS, and scenarios of converging technologies developed by the University of Oxford's James Martin Institute, UK. Particularly when coupled with engagement activities, the creation of such anticipatory knowledge can help the public voice its concerns about looming socio-technical change.

Anticipatory governance further prescribes the integration of engagement and foresight with scientific and technical work. This informs social scientists' own perspectives with cutting-edge research. It also increases the capacity of natural scientists to understand the societal aspects of their own work, be more reflective about practices and choices within the laboratory and if necessary change their practices to align their research with public visions and values. Such activities have occurred in many small-scale trials. Social scientists and humanists have 'embedded' themselves in research laboratories to become active participants in laboratory activities both to observe researchers and to prompt a more reflexive disposition among them, even modestly reorienting their work in more socially robust directions. The integrative activities at the CNS, for example, are beginning to catalogue concrete, positive consequences within laboratories. Our nanoscientist colleagues report helpful changes and desire more such interactions.

"Global society needs much of what knowledge-based innovation has to offer."

Beyond nano

The engagement, foresight and integration activities listed here are still too few and too far between. The scale of the research enterprise and the scope of innovation policies dwarfs them. Their few demonstrated successes are not well-disseminated. And they are not linked together in a way that supports anticipatory governance. Yet these early steps offer a prudent approach for innovation policy for nanotechnology and other fields including synthetic biology and neuro-technologies.

Global society needs much of what knowledge-based innovation has to offer. Anticipatory governance is a necessary exercise. It defrays the inherent contradictions of innovation policy, while ensuring that public values and foresight accompany scientific practice, keeping the revolution from turning unproductively against itself and against us. ■

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