Sustainability, substitution and synthetic biology

Alice Benessia[a] and Silvio Funtowicz[b]

a. Dipartimento di Scienze Umane e Sociali/ Département des Sciences Umaines et Sociales, Università della Valle d'Aosta / Université de la Vallée d'Aoste, Aosta, Italy

b. Centre for the Study of the Sciences and the Humanities (SVT), University of Bergen, Bergen, Norway

In our most recent work we have analysed some of the main contradictions and paradoxes arising within a dominant, inherently modern framing of sustainability (Benessia *et al.* 2012, Benessia and Funtowicz 2013, Benessia and Funtowicz *in print*) relying on technoscientific innovation in order to describe, confront and solve our present human predicaments (environmental, social, economic, cultural and political). We have explored this framing as evolving from the institutional discovery of sustainable development as a global issue in the 1992 Rio Conference, when it was associated with diversity, participation and precaution, to the Rio + 20 Conference when sustainable became merely an adjective of growth (Brand 2012).

Along this narrowing path, the distinction between weak and strong sustainability has been progressively fading and the mainstream economics ideal of replacing the natural with manufactured artefacts is now leading the way towards a sustainable future. More generally, in its intersection and co-evolution with innovation, the notion of sustainability becomes more uncertain and ambiguous, as both influencing and being influenced by the mutable boundaries of technoscience. On the one hand, the modern discourse about sustainability in all its contradictions is functional for preserving the technoscientific path-dependent trajectory on its track despite its ever increasingly socially and politically controversial aspects, while remoulding the very definition of what science is and does. On the other hand, the issues of "What to sustain?" and "For whom?" are deeply modified by the technoscientific enterprise.

The unchallenged economic policy aims of growth, productivity and competitiveness - reinforced during the financial and economic crisis both in Europe and in the US - are fundamental ingredients of this whole scenario. If we keep these goals as givens for improving, extending and even equalizing[1] human welfare on this planet, then we (continue to) face the paradox of sustaining an accelerating increase in our global resource consumption within a complex, closed and finite system, with limited stocks and bio-geo-chemical resilience[2].

The dominant discourse about a way out of this paradox comes from the grand narrative of technoscientific innovation, which serves a double purpose. As the first line of reasoning reads, we need to take into account an essential hidden variable, which Malthus first proverbially overlooked: natural supplies might be limited, but human creativity is *unlimited*, and so is human potential to: (1) decouple growth from scarcity, improving efficiency in the use of natural resources and ultimately substituting them altogether, with substantially equivalent technological optimised artefacts; (2) tame complexity, uncertainty and the risks of failures through the implementation of effective *ad hoc* technoscientific silver bullets. Secondly, innovation is taken as the mainstream solution in order to keep sustaining growth in a hyper-saturated market, by opening up new pathways of competitiveness and consumption, to be filled with new, constantly upgraded and more seductive, products and services.

Another fundamental element needs to be in place for this whole narrative to be viable: citizens of developing, developed and declining economies have to value and ultimately buy - both metaphorically and

1 See the internal debate around capital and raising inequality in relation to the publication of "Capital in the XXI Century" by Thomas Piketty (2014).

2 Ulanowicz's notion of hypercycle provides a useful description of this paradoxical dynamics and of its unsustainability (Ulanowicz 1986).

literally – the processes and products of technoscientific innovation. This means that the societal expectations about the goods have to be encouraged and the concerns about the bads to be deflected (EC 2013, ESF 2009).

Synthetic biology has positioned itself within this grand narrative of innovation and sustainability just like any other emergent (and emerged) technology platform (Benessia *in print*). However, its response consists on a unique strategy of demarcation between science and technology, based on a promise and a principle of substitution. The first two lines of argument are addressed by proposing the industrial standardization and optimization of the *bios*, conceived as a Cartesian *res extensa*, an inert substratum to act upon in the most productive and controlled way (STOA 2011, Philip 2014).

Synthetic biology enters into the discourses of biodiversity protection and clean energy production (Wiek *et al*. 2012), by promising to restore to life extinct species (de-extinction) and even expand the canvas of the *bios*[3], and by proposing a complete transition from fossil fuel-based economy to bio-based economy, through the development of renewable biofuels (Mackenzie 2013). The scarcity of natural resources and market shares can then be *substituted* with the abundance of synthetic goods and a plethora of new products and marketable possibilities can revitalize struggling economies[4]. In this context, synthetic biology is defined and described in terms of a strictly technological endeavour, emerging from the triad of biotechnology, nanotechnology and ICT.

In response to the third structural element of the narrative of innovation - i.e. the need for public acceptance and endorsement – synthetic biology becomes a tool for scientific enquiry and education, thus needed for the ultimate exploration of the wonders and mechanisms of life. More precisely, and much more radically, it becomes a science by changing what science *is*. Indeed, by intertwining Baconian pragmatism, Cartesian reductionism and Vico's principle of "verum et factum convertuntur"[5] with a validating reference to Richard Feynman's epigraph on a Caltech blackboard[6], synthetic biology defines a new principle of demarcation in which knowing and making are identified. As Evelyn Fox Keller points out (2009), this fundamental epistemic move implies the *substitution* of science itself with technology, a development consistent with the process of commoditization of science (Mirowski, 2011).

While some continuity can be traced in the narrative strategies of the contemporary technosciences it springs from[7], synthetic biology stands out for its awareness and explicit treatment of complexity, both within and outside its own boundaries. In order for knowing and making to be identifiable and technology to *become* science, a fundamental epistemic and normative assumption has been made and implemented: complexity must be recognized and explicitly assessed as a burden to be eliminated. This eradication of complexity seen as an impediment on the way to optimization and complete substitution is the foundation stone of both Craig Venter's creationist approach and Drew Endy's standardizing and democratizing notion of open source BioBricks™ bank (Le Fanu 2009, Mackenzie *et al.* 2013).

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3 The idea of substituting natural biodiversity with a synthetic one can be seen as a consistent development of the concept of Ecosystem Services, leading to mapping, measuring and counting the goods and services of ecosystems in monetary terms (Turnhout *et al.* 2013).

4 The principle of substantial equivalence, already at work within the framework of both bio and nano technologies, provides a scientific and normative base to this ideal of substitution.

5 "The true and the made are reciprocal" Vico 1710.

6 The (misquoted) version of Feynman's text is: "What I cannot build, I cannot understand".

7 Richard Feynman is also evoked as the founding father of nanotechnology ("There is plenty of room at the bottom"). As a Nobel laureate for the formulation of Quantum Electro Dynamics (QED), a well renowned science educator and an acute science investigator at NASA after the Challenger's explosion, his figure can be regarded as the perfect bridge between modern curiosity oriented science and contemporary corporate technoscience, therefore responding to the demands for public acceptance of the technoscientific enterprises after the biotech clashes (Benessia and Funtowicz 2013).

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