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ECOCOM 680 No. of Pages 8

ARTICLE IN PRESS

Ecological Complexity xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Ecological Complexity

journal homepage: www.elsevier.com/locate/ecocom

Original Research Article

Cyborged ecosystems: Scenario planning and Participatory Technology Assessment of a potentially Rosennean-complex technology

Yorgos Marinakis[a,*], Rainer Harms[b], Bruce T. Milne[c], Steven T. Walsh[a]

[a] Anderson School of Management, University of New Mexico, Albuquerque, NM, 87131, USA
[b] NIKOS, School of Governance and Management, University of Twente, Enschede, The Netherlands
[c] Department of Biology, University of New Mexico, Albuquerque, NM, 87131, USA

ARTICLE INFO

Article history:
Received 1 March 2017
Received in revised form 13 October 2017
Accepted 23 October 2017
Available online xxx

Keywords:
Cyborged ecosystem
Participatory Technology Assessment
Rosennean complexity
Scenario planning

ABSTRACT

Public involvement in technology policy making is particularly relevant because technological development is now reaching into virtually all planetary systems. The advent of Genetically Modified Organisms (GMO) for human food is particularly controversial, and it also raises questions about related technological-based potential products such as cyborged organisms in general. The research question in the present study is, what are the results of a Participatory Technology Assessment of cyborged ecosystems? The method utilized is Participatory Technology Assessment, implemented through scenario planning. The result of the study was three core themes: superfluous technology, dangerous tampering, and potential public health consequences. Resonances were observed between answers by laypersons and experts, indicating that they recognized the same issues but expressed themselves using different vocabularies and with different levels or types of understanding. Criteria are needed to ensure the public is able to engage in policy decisions that involve Rosennean-complex technologies.

1. Introduction

Public faith in the competence of governmental oversight has been eroding in both the United States (Light, 2006; Ashford, 2007; Lofstedt, 2011) and Europe (Lofstedt et al., 2011). The disenchantment is pervasive, from finance (Jabłecki, 2016) to health care (Curtis and Schulman, 2006; Marlow, 2015). The United States Environmental Protection Agency is a target for those alleging either governmental overreach or unnecessary deregulation (Pugsley, 2012). Genetically modified crops are allegedly variously overregulated (Miller, 2001; Ammann, 2014; DeFrancesco, 2013), in danger of overregulation (Qaim, 2009), or underregulated (Schubert, 2016). If the government is widely believed to be the problem, how can the government ever be the solution?

One possible response to this public disenchantment in government is increased public participation in policy making. Governmental and non-governmental efforts in this regard, such as the Public Understanding of Science (Joly and Kaufmann, 2008), upstream engagement (Heidingsfelder et al., 2015), and Participatory Technology Assessment (Bierwisch et al., 2015; Tavella, 2016), have indicated the oceanic immensity of the subject and the trivial gains to be expected from well-intentioned and competent efforts. The deployment of Participatory Technology Assessment, in particular, has been a slog (Rask, 2013).

Public involvement in technology policy making is particularly relevant because technological development is now reaching into our food sources. The advent of Genetically Modified Organisms (GMO) for human food is itself controversial, and it also raises questions about related technological-based potential products. What about the possibility of cyborged organisms for human food (Saguaro, 2006)? What about the release of a cyborged biotic system from out of the laboratory (e.g., into private agricultural lands)? How should the risk be managed? Does the burden of proof of public safety lie with the advocate, or does the burden of proof of public danger lie with the protestor? Public adjudication of these questions presupposes public understanding of these technologies, and this regression once again illustrates the immensity of the issue.

The research question in the present study is, what are the results of a Participatory Technology Assessment of cyborged ecosystems? The ecosystem question is timely because it resonates with the contemporary Environmental Internet of Things (EIOT, Hart and Martinez, 2015), itself a non-autonomous, evolving

* Corresponding author.
E-mail addresses: ymarinak@unm.edu (Y. Marinakis), r.harms@utwente.nl (R. Harms), bmilne@sevilleta.unm.edu (B.T. Milne), swalsh91@comcast.net (S.T. Walsh).

https://doi.org/10.1016/j.ecocom.2017.10.005
1476-945X/

system of novel risks beyond human control. At the same time it reminds us of earlier attempts at developing biosystems with Artificial Intelligence, or "Ecocyborgs" (Clark and Kok, 1998; Clark, 1999). The notion of synthetic or partially synthetic ecosystems lies at the confluence of a number of independent research threads. Some of these research threads are motivated by practical interests. Life Support Systems (Hendrickx et al., 2006), for example, are a product of the human desire to colonize outer space. Other research threads are motivated by purely scientific, academic interests. Basic research into the synthesis or construction of an artificial ecosystem (Clark, 1999) is of the same genre as basic research into artificial life.

2. Theoretical background

2.1. Participatory Technology Assessment

Participatory Technology Assessment is a method that informs governmental policy making with citizen preferences and values. Participatory Technology Assessments have used scenarios in cases of emerging technologies involving multiple stakeholders (technical and non-technical) and complex technologies (Bierwisch et al., 2015; Tavella, 2016). Scenarios are successful under these conditions because they can show how the future might develop from a given decision. Public involvement is invoked in both expert-based decision making and in participative democratic processes (Lach and Sanford, 2010). In the former, the purpose of public involvement is to develop a scientifically literate public that will accept expert opinions and decisions. In the latter, the purpose is to democratize the decision making process. The two decision making processes differ in important ways, but both seek to increase public understanding and involvement.

Public involvement at the assessment of a technology is sometimes called upstream engagement, but this terminology has critics. The policy of upstream engagement originated in response to the Public Understanding of Science (PUS). The PUS is based on asymmetry between experts and the general public. It has been skeptically critiqued as a deficit model that assumes that the general public are empty vessels "to be educated and informed in order to secure support for innovation and reduce social resistance to technology" (Joly and Kaufmann, 2008: 226).

The newer policy of upstream engagement or public engagement is based on symmetric communication between experts and the general public, and it often involves the construction of hypothetical technological scenarios (Heidingsfelder et al., 2015). This newer policy is particularly relevant to cyborged ecosystems and other potentially Rosennean-complex technologies because it envisions two-way communication at early stages of technology development between experts and the general public. Upstream engagement may be considered as not just a precursor but as a prerequisite to relevant social groups. Upstream engagement has also been criticized as embedded in the "linear model of innovation as a one-way flow from basic research to the users" and as being ineffective against powerful and established technology commercialization interests (Joly and Kaufmann, 2008: 231). In the linear model, innovation is considered to be irreversible: it is out of the question that Genetically Modified Organisms, or nanotechnology, could ever be retired. That means that if the public is consulted after the vested interests have already taken a major decision, then that major decision is considered as irreversible and not up for discussion or reconsideration. In the linear model, the innovation process demonstrates increasing returns on investment, path dependency and lock-in (Arthur, 1989). What may be more commensurate is a type of innovation that engages and transforms a system and its constituents in its totality, as a whole, as well as its parts. This model of innovation is neither linear nor non-linear, but is rooted in Morin's (2007) notion of generalized complexity, discussed below, in which whole-part relationships are considered.

2.2. The public consultation process: context, stakeholders, scenarios and post-scenarios

The co-creation of technology by experts and the general public requires a meeting place and an embedding process to host scenarios. One specific implementation of scenarios is the Shaping Future model (Heidingsfelder et al., 2015). The Shaping Future model was proposed as a scenarios-based tool for public engagement in technology policymaking. The model responds to the European Commission's Responsible Research and Innovation (RRI) Framework, which has the goal of bridging the gap between the scientific community and society at large (EC, 2012). The RRI Framework comprises six keys, which are engagement, gender equality, science education, open access, ethics and governance. The Shaping Future model proposes a process in which researchers and designers pass technology-related theoretical findings and design know-how over to panels of laypersons. These panels of laypersons evaluate the technology in a series of workshops, with the goal of constructing scenarios that can function as starting points for research agendas. The results of these workshops are then passed over to specialists, who convene their own workshops to develop technology roadmaps.

2.3. The research context: cyborged ecosystems and Rosen's concept of complexity

A cyborg is an exogenously extended organizational complex functioning (in the case of an animal, that functioning is automatic or unconscious) as an integrated homeostatic system (Clynes and Kline, 1960: 27). The word cyborg first appeared in 1960, but the cyborg concept arguably owes its existence to the multitudes of soldiers wearing prosthetics returning from World War I battlefields (Borck, 2005; Biro, 2007). The term originally referred to extended humans (Clynes and Kline, 1960). It has since been applied to other species such as insects (Matic et al., 2014; Zhang et al., 2016) and rats (Yu et al., 2016). Cyborging means combining technological and living systems to make a cyborg.

The cyborg under consideration in the present study is the cyborged ecosystem. An ecosystem is an organizational complex of biotic elements and their abiotic environment, putatively functioning as an integrated homeostatic system (Marinakis, 2007). Research specifically on cyborged ecosystems has received only limited attention (Clark and Kok, 1998; Clark, 1999; Vandermeer and Perfecto, 2017). Ecocyborgs are "biosystems of the ecosystem scale that are composed of large sets of both biological and technological components which function in an integrated manner" (Clark, 1999: 120). Applied research in this area is underrepresented. In the Ecocyborg Project, computer models were used to investigate the engineering of large-scale biosystems (ecosystems) combined with Artificial Intelligence control networks (Clark and Kok, 1998; Clark, 1999). The original prototype comprised a physical greenhouse with a system that included sensors, effectors, and controllers connected to computers. Due to lack of funding, further work was limited to computer modelling (Clark, 1999: 41).

The public assessment of cyborged ecosystems is a particularly hard problem because some believe that ecosystems are complex, and others do not. The nature of ecosystems as complex or not will likely impact whether a layperson views cyborging as a threat or not. We do not seek to adjudicate whether ecosystems are complex. We seek to investigate a forum or venue in which members of the public can productively discuss this issue.

Please cite this article in press as: Y. Marinakis, et al., Cyborged ecosystems: Scenario planning and Participatory Technology Assessment of a potentially Rosennean-complex technology, Ecol. Complex. (2017), https://doi.org/10.1016/j.ecocom.2017.10.005