Technology Assessment: A Role for UNESCO and S&T Parks

Deog-Seong Oh[1], Fred Young Phillips[2]
[1]National Chungnam University, Korea
[2]Yuan Ze University, Taiwan

***Abstract*--Globalization and information/communication technology, as well as new modes of assessment, have opened new prospects for the practice of technology assessment. These prospects hold the potential for realizing the technology assessment role that has long been recommended for UNESCO and other United Nations agencies. They may also solve the problem of research parks that, as "hybrid organizations," have failed to mesh with the cultural values of their surrounding communities. This paper highlights the new prospects for assessment, and identifies the institutional gaps in assessment practice. We propose, as a solution, that assessment become a function of an international network of research parks, with the official recognition and clearinghouse services of an international agency. We find this proposal aligns well with the recent technology assessment literature and its implications, and we put forth the Daejeon/ UNESCO Global Innovation Forum as a possible network platform.**

I. INTRODUCTION

Technology assessment is "the sociotechnical research that discloses the benefits and risks to society emanating from alternative courses in the development of scientific and technological opportunities" [14]. This use of the word assessment is to be distinguished from its uses in for example, "program assessment" or "teacher assessment" [24]. Technology assessment (TA) can focus on the short-term risks to individuals of using a new food additive, for example, or more usually [16] on the long-term social (shared) impacts of something like the mobile web.

Recent decades' changes in technology and global politics have opened new prospects for the practice of technology assessment. These prospects hold the potential for realizing the technology assessment role that has long been recommended for UNESCO and other United Nations agencies. They may also solve the problem of research parks that, as "hybrid organizations," have failed to mesh with the cultural values of their surrounding communities.

This paper highlights the new prospects for assessment, identifies the institutional gap in assessment practice, and proposes a solution. Via literature review and logical argument, we show how science parks can help resolve the dilemmas of TA while at the same time improving their own station.

II. THE FUNDAMENTAL DILEMMAS OF TECHNOLOGY ASSESSMENT

In this section we describe the gap between commercial time-to-market and the time needed for exhaustive technology assessment, and the identity anxiety of research parks, concluding that the two problems might solve each other.

A. The commercial dilemma

A company competing against others wishes to release each of its new products into the marketplace as early as possible. The time between the onset of customer demand and the capture of market share by a competitor's product – or by a next-generation technology – is called the product's market window. Companies consider the market window for innovative products to be narrow, i.e., spanning just a short amount of time.

Fig. 1 presents the example of a hypothetical new building material that proves to be carcinogenic. The horizontal "base rate" line indicates that a certain fraction of the population will contract cancer even without exposure to the new material. New cancer diagnoses due to the new material are not likely to be directly traceable during the market window. Measurement of new cancers between people exposed to the new material and people not exposed is not likely to show a statistically significant difference. Cancers may occur immediately, but are more likely to take years or decades to develop [23].

A confident assessment cannot then be made before the product is introduced to market. This is the fundamental dilemma: Time needed for assessment almost always far exceeds the maker's market window.

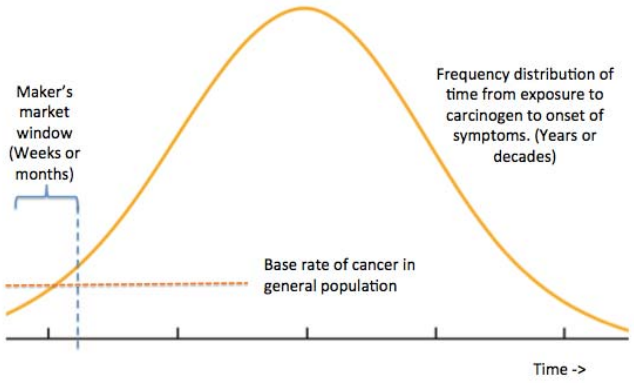

Figure 1: Does a new building material cause cancer? Why it's "hard to tell"

Looking now at the diffusion (cumulative market penetration) curve, Fig. 2, we see that a significant proportion of users of the product will make their first purchase before the assessment is complete. The implication of this simple math is this: If use of the product proves harmful, it will harm many people, and it is not likely that the manufacturer will

pay for remediation. Cases like the U.S. tobacco and asbestos class action settlements are extremely rare, and even then did not compensate all victims. Individual lawsuits against large manufacturers may stay in litigation longer than the plaintiff's remaining lifetime, and cost more than her net worth.

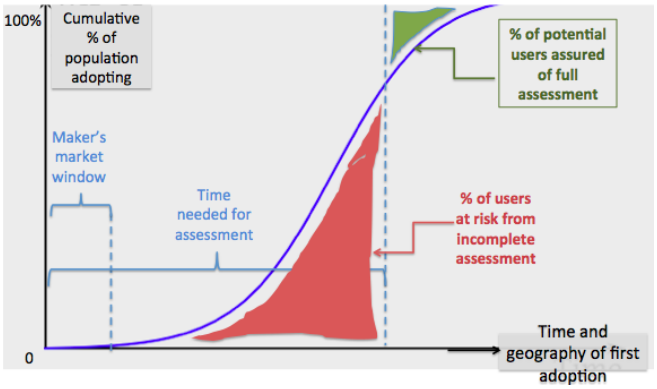

Figure 2: Populations at risk

It is not only the seller's push that brings innovations to market before their risks are understood. Social pressure – based on appeals to gender equity given the recent flood of products to aid male sexual readiness – accelerated the market availability of the female libido-enhancing drug filbanserin. This was despite mouse studies that suggested an increase in breast cancer among the treatment group. The situation is mitigated by the drug having gone through the US Food and Drug Administration approval process, as this process is seen as making customers more comfortable buying the drug. However, "the clinical studies were too short to estimate long-term risks" [22].

This shows that an authoritative body can influence consumers' acceptance of a new product. It also highlights that the early introduction can bring real (though perhaps short-term) benefits to the users, even though the risks remain unknown.

An assessment performed too soon may fail to detect – or imagine – an adverse impact. One performed too late risks seeing causation clouded by intervening events and environmental changes.

B. The research park's dilemma

Dierdonck et al [6] suggest science parks suffer from identity anxiety, resulting in "ambiguous performance" and split loyalties. Gulbrandsen [8] offers more detail, asserting that research institutes (and by implication, parks) "can be considered hybrid organizations, caught in between dichotomous cultural spheres with differing values. To retain their hybridity and to survive in the long run, research institutes need to create and sustain organizational legitimacy by establishing congruence with values from these different spheres." Fig. 3 illustrates this idea.

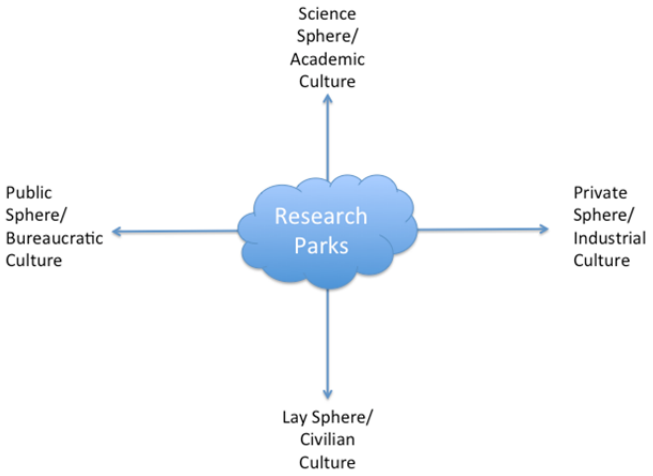

Figure 3: The ambiguous identity of research parks – caught between cultures Figure adapted from Gulbrandsen [8]

We will suggest in this paper that technology assessment (TA) is an activity that holds appeal for all four cultures of Fig. 3. Battelle [2] reports that 56% of US university-affiliated research parks perform technology and market assessments. Battelle's report does not separate market assessment from technology assessment, and we suspect that most of the park's assessment activities are on the market side. Nevertheless it is telling that the parks regard TA as a legitimate part of their missions, and common enough that it should be measured in this survey.

A third dilemma stems from the substantial, though dated, literature urging the United Nations and UNESCO in particular to take a role in collaborative TA. This advice faced obstacles of cost and distance in the pre-Internet age. We will show how recent developments have now made it practicable.

III. THE PRESENT DAY: TECHNOLOGY ASSESSMENT AROUND THE WORLD

Table 1 introduces several organizations currently involved in TA, noting the form of each organization and its geographic area of responsibility.[1]

Most of these agencies engage in public policy-oriented TA. Moreover, only SPRU and the Norwegian agency assume a global mission. As deregulation sweeps varied regions of the world, the agencies' agendas appear outdated. Porter [16] explains the trend in TA from a regulatory focus to a participative focus involving multiple-constituency dialog. The title of another of Porter's articles [17], "Impact assessment methodology is too insular," says it all, although he was addressing disciplinary rather than geographic insularity.

[1] Additional agencies performing policy-oriented TA are listed at www.technology-assessment.info/index.php/institutes, and more are noted in Coates et al [5].

TABLE 1. REPRESENTATIVE TECHNOLOGY ASSESSMENT ORGANIZATIONS

Organization	Mission	Gov't/Private/NGO/Academic	Geographic Scope
Centre for Technology Assessment (TA-SWISS), Bern, Switzerland.	Identify the social, legal and ethical consequences of new technologies	Swiss Academies of Arts and Science	Member of the European Parliamentary Technology Assessment
Institute of Technology Assessment (ITA) of the Austrian Academy of Sciences, Vienna	Studies the impact of new technologies on the environment, economy and society	Austrian Academy of Sciences	EU and Austria
Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT), Germany	Focus on tech impacts and possible systemic and unintended effects. Assessments of socio-technical policy and design options for decision-makers.	University	Mostly Germany, Austria and Switzerland. Member of several international networks.
The Danish Board of Technology Foundation, Copenhagen	Create platforms for combining participants' knowledge in the search of sustainable solutions	Danish Ministry of Science, Innovation and Higher Education	Worldwide
Norwegian Board of Technology, Oslo	Explores societal impacts and options of technology and science; stimulates public debate on technology; advises Norwegian Parliament and other governmental bodies on technological issues. Monitors international technological trends and methods for TA.	Independent body established by the Norwegian Government	EU and Norway
Parliamentary Office of Science and Technology (POST), London			
Rathenau Institute, The Hague	Promotes the formation of political and public opinion on science and technology	Independent, autonomous organization under Royal Netherlands Academy of Arts and Sciences	The Netherlands
Science and Technology Options Assessment (STOA) panel of the European Parliament, Brussels	Assessment of scientific and technological policy options for the European Parliament	Official organ of the European Parliament	Most of Europe
Science and Technology Policy Research (SPRU), Sussex	Science, technology and innovation policy generally	University	Global

A. U.S. organizations concerned with technology assessment

Until its de-funding in the 1980s, the U.S. Office of Technology Assessment (OTA) advised Congress on technology development issues that could affect legislation. OTA fell to the wave of small-government sentiment that swept the U.S. in that era. Agitation to revive the OTA now comes from many quarters, for example [18,20, 28].

In May, 2015, the U.S. Department of Commerce's Economic Development Administration (EDA) announced $5 million in funding for recipients of the 2014 Science and Research Park Development Grants, "used for feasibility and planning for the construction or renovation of science or research parks" [21]. However, the EDA Annual Report [25] does not mention technology assessment as a function expected of grantees, and (despite the statistic given in the 2013 Battelle report) in fact does not mention TA at all.

The International Association for Impact Assessment (iaia.org) is a private non-profit membership organization based in the United States. It is concerned with disseminating assessment methods applicable to any kind of action, not just technology developments, and appears to focus mostly on environmental matters [16].

B. International agencies concerned with technology assessment

Publications urging a TA role for UNESCO date back at least to Brooks' 1973 paper [3]. Wad and Radnor [26] emphasized the importance of TA for developing countries:

> It is only natural that technology assessment be viewed with considerable interest in the context of development. Science and technology are increasingly seen as crucial components of development and growth, and many of the problems of underdevelopment have been attributed to weak indigenous science and technology capacities, inappropriate technological choices, poor technological development policies and dependency-producing transfers of technology. All these problems underscore the need for a capability to assess technology in the context of the development strategy of a country.[2]

[2] Wad and Radnor cite two other early UN technology assessment meetings, Report of the United Nations Seminar on Technology Assessment for Development, Bangalore, India, 30 October-10 November, 1978. Department

We surmise the lack of high-profile action stemmed from the expense of travel and communication in that era, and its slower pace of technological change.

At a 2003 roundtable organized by the Parliament of Finland and UNESCO, delegates from 31 countries cited the successes of European Parliamentary Technology Assessment (EPTA) and the Council of Europe in formulating the Helsinki Declaration.[3] The Declaration urged the creation of mechanisms for better connecting innovation systems with policy formation, and the setting up of an international forum, composed of diverse constituency groups, to discuss technology-related aspects of regulation.

While we believe the focus can no longer be exclusively regulatory, we agree that a network of organizations facilitated by an international agency is key to the future of TA. The Daejeon UNESCO Global Innovation Forum (DGIF)[4] may well grow in this direction.

We mention in passing that UNESCO has taken on TA-like tasks in the field of educational technology [12,19].

The World Health Organization (WHO) engages in TA also. Recently, WHO took a stand regarding the transparency of clinical trials of new drugs, issuing detailed guidelines [13].

IV. THE NEW CONDITIONS AND OPPORTUNITIES FOR TECHNOLOGY ASSESSMENT

Much has changed since the above-cited, and now dusty, UN technology assessment publications of the 1970s and '80s.

- Governments have less control over technology developments. In the USA, except for drugs and some telecomm products, regulation has all but disappeared. Innovators like Uber, knowing they are probably violating at least municipal ordinances, bring their products to market and dare governments to respond.
- Globalization and the open innovation movement mean that new products have components sourced from multiple countries with mutually inconsistent regulatory regimes. Moreover, finished products are marketed globally. Some that are lightly regulated in the USA (like many of Google's and Microsoft's) find regulatory difficulties in Europe.
- Information and communication technology (ICT) and online collaboration platforms enable global research teams. To the extent that scientists do think about social implications of their work – and this is perhaps still too rare – multinational research teams ensure diverse cultural takes on the desirability and priority of different technological directions. This is enhanced by the Internet's new capabilities for bibliography and bibliometrics [16].
- The increasingly global, systemic, and externality-creating nature of today's innovations.
- The rise of collaborative TA.

We offer more detail about the latter two points.

Keller [10] cites a report indicating "innovators are pivoting to areas where they can truly make an impact." Indeed, some press stories[5] claim innovators are taking on important world problems. Others[6] excoriate Silicon Valley innovators for their trivial offerings [11, 27]. The large number of innovations having social media components, in which buyers and sellers bring third parties into the picture, means that these innovations, at least, are systemic. We believe more problems – and more innovations – will be systemic, whether they are individually important or trivial.

Table 2 lists some innovations illustrating this point. Fig. 4 conceptually portrays the displacement of transactional innovations by systemic innovations.

Why is this important? From a technical perspective, it means for a given technology, we cannot separate an assessment against Risk A from an assessment against Risk B, etc., because most effects are systemic and inseparable. Google's (and Volvo's and Ford's) driverless cars are a case in point: Small-scale tests to date fail to prove scalability, as the complexity of the autonomous vehicle network increases supra-linearly with the number of cars and the variety of road conditions.[7]

From a humanitarian perspective, it means persons not party to an exchange transaction must not be thrown to the alligators. "Bystanders" should not unwillingly be subject to the effects of an innovation, especially if there is good reason to believe it will harm them more than help them. Theoretically, it means the Theory of Externalities should take on greater importance in academic economics.

---

of International Economic and Social Affairs, New York, 1979; and United Nations Secretariat, Report of the Expert Group on Technology Assessment, convened under the auspices of the Office of Science and Technology of the United Nations Secretariat, New York, 23-27 June 1975.

[3] http://www.unesco.org/new/en/natural-sciences/science-technology/science- legislation/ helsinki-declaration/. DGIF member Dr. Mustafa El-Tayeb led this roundtable.

[4] www.daejeongif.org

[5] http://www.psmag.com/business-economics/on-the-global-innovation-slowdown

[6] http://www.washingtonpost.com/blogs/innovations/wp/2014/06/23/come-on-silicon-valley-you-can-do-better-than-this. Also, http://www.technologyreview.com/review/534581/the-purpose-of-silicon-valley/

[7] http://www.thelowdownblog.com/2016/02/driverless-cars-struggle-in-snow.html

TABLE 2: SYSTEMIC NATURE OF TODAY'S INNOVATIONS

Impact of Innovation	Examples	Effects
Transactional; Affecting only buyer and seller	Phone app to find, rate public toilets	Convenience, comfort
	Acetaminophen	Pain relief
Systemic; Externality-generating; Global or multi-local in impact	Geo- engineering	Global climate change mitigation
	Fracking	Earthquakes, contaminated ground water
	Fast food	Obesity
	Genetically-modified seed	Impoverished small farmers
	AirBnB	Increased urban real estate prices
	Financial globalization	Favors large investors
	Freon substitutes	Saves ozone layer
	Cell phones, cell phone lots	Saves time, fuel at airport pickups

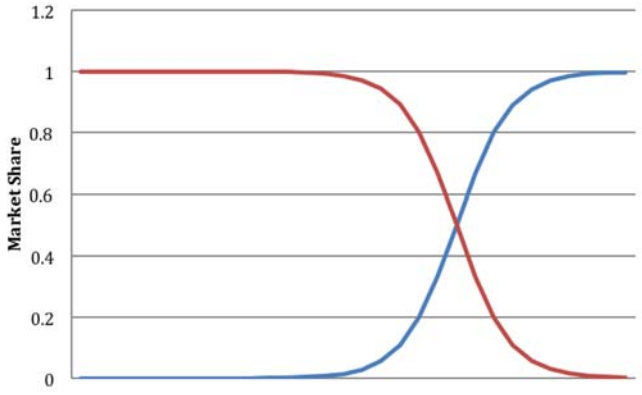

Figure 4. The trend toward systemic innovations.
The blue line shows the growing share of innovations that are systemic, global, and affecting others than buyers/sellers. The red line shows the share trend of transactional innovations affecting only buyers and sellers.

We have listed the main agencies now performing TA, and have listed some current developments that change the requirements for TA. We now ask, under the new conditions, who could and should do TA? In this way we return to the matter of collaborative TA.

TABLE 3: WHO COULD DO TA IN TODAY'S WORLD?

- Before product introduction
  - Companies
  - Governments, e.g., FDA
- After product introduction
  - Governments
  - NGOs (Trade Associations, Industry Associations)
  - Companies
  - Ad hoc groups
  - Daejeon Global Innovation Forum
  - S&T Parks
  - Global networks of users
  - Local user groups

The Table distinguishes between assessments done before a product is launched to market, and those done after. Before launch, the product development project is usually (except for any advance hype) confidential within the company. Government-mandated exceptions include new drugs and some other products. In those cases, government is involved in pre-launch TA.

Of course TA may also be done at the pre-competitive stage of a technology, i.e., between patent application and new product development. For example, trade associations were instrumental in assessing replacements for chloroflourocarbons as coolants in air conditioners and refrigerators [4]. Porter [16] notes other laudable private-sector TA efforts.

After a new product is launched, many options exist for TA. Each has disadvantages. Trade and industry associations have member firms that compete with each other. User groups (and even networks of user groups) may not have the needed expertise. Governments may be too controlling. For these reasons, we favor global networks of S&T parks, with the support of an international agency and supplemented by community involvement, to perform TA with the right mix of expertise, authority, and credibility.

Baltimore et al [1] provide a high-profile example of collaborative TA, and makes some telling points about it. Among the co-authors were David Baltimore (1975 Nobel laureate in Physiology/Medicine, Past-president of the American Association for the Advancement of Science, and U.S. National Medal of Science winner), Paul Berg (Nobel Laureate in Chemistry, and U.S. National Medal of Science winner), and Jennifer Doudna (Fellow, US National Academy of Sciences and one of *Time* magazine's 100 most influential people in the world). Their paper describes how "a group of interested stakeholders" met under the banner of the Innovative Genomics Initiative (IGI) Forum on Bioethics in Napa, California, "to discuss the scientific, medical, legal, and ethical implications of new prospects for genome biology." The meeting was sponsored by the University of California; most of the authors attended the meeting.

The present authors do not subscribe to the precautionary principle, (see [15]); neither do Baltimore et al. [1]. The latter's position is stated concisely: When innovations pose risks, "[greater] risks also demand higher confidence in [the innovation's] likely efficacy."

Their further recommendations[8] are in terms of genomic engineering but have broader application [1]:

In countries whose regulatory agencies focus on safety and efficacy but not on broader social and ethical concerns, [a non-governmental] venue is needed to facilitate public

[8] In response to an email from Fred Phillips inquiring about the efficacy of an ad hoc group doing TA (even with Nobel Laureates as members!), Prof. Doudna replied that their efforts continue but it is too soon to make conclusions.

conversation.

Given the speed with which the genome engineering field is evolving… there is an urgent need [to create forums] for open discussion of the merits and risks of human genome modification by a broad cohort of scientists, clinicians, social scientists, the general public, and relevant public entities and interest groups… and where appropriate, recommend policies.

Strongly discourage, even in those countries with lax jurisdictions where it might be permitted, any attempts at germline genome modification for clinical application in humans, while societal, environmental, and ethical implications of such activity are discussed among scientific and governmental organizations.

Encourage and support transparent research to evaluate the efficacy and specificity of CRISPR-Cas9 genome engineering technology in human and nonhuman model systems relevant to its potential applications for germline gene therapy. Such research is essential to inform deliberations about what clinical applications, if any, might in the future be deemed permissible.

V. SUMMARY, AND AN ACTION PROPOSAL FOR RESEARCH PARKS, UNESCO, AND DGIF

We have presented evidence from scientific literature and from the press that support the following points:

- Pressure to bring an innovation to market quickly conflicts with the need for deliberative technology assessment. A mediating mechanism is needed to ease this dilemma.
- Current TA organizations have geographically and politically delimited responsibilities, in the face of ever more global innovation impacts.
- TA is important for developing countries [26], which are an important UNESCO constituency. Protecting the weak against global threats is the job of multi-national organizations.
- Research parks are caught between cultures, resulting in confused identity and possibly reduced effectiveness.
- An authoritative institution can affect customers' uptake of new technologies. In some situations, however, it is better if this institution is non-governmental.
- Earlier discussions of TA urge the formation of international, multi-constituency forums, conducting networked discussions. This advice was impractical prior to the kinds of online global collaboration platforms that are available to the Daejeon Global Innovation Forum (and part of DGIF's charter).
- Brainstorming not expensive. However, TA involves more than brainstorming; it does require follow-up laboratory research. As "technology-followers," many developing countries cannot do cutting-edge scientific research. TA-oriented lab research, aimed at identifying e.g. the least risky application areas and market segments for a new technology, does not require cutting-edge capability. As such, it may be ideal for universities and research parks in developing economies.
- Politics led to the demise of the US OTA. Eijndhoven [7] points out that TA must navigate the shoals of both science and politics. A decentralized, worldwide network of TA laboratories will be resilient against localized political pressures, and will remedy the insularity that Porter [17] highlighted.

Problems, solutions, and environmental conditions appear in some regions of the globe sooner, and in other regions later or not at all. A global network of TA centers can arbitrage these temporal differences to ease the time-squeeze that earlier in this paper we called the "fundamental dilemma" of technology assessment.

It seems widely perceived that deregulation sometimes primarily benefits consumers, and sometimes primarily benefits investors. This can be a contentious issue. However, when TA has an impact, it may be on regulation, but it could equally be on vendor behaviour directly, on consumer choice, or on thoughtful research choices on the part of scientists and engineers. Being pro-TA does not imply being pro- or anti-regulation.

To their traditional roles of teaching, scholarship, and community service, many universities have recently added a fourth role: Commercialization of innovations for regional economic development. Following this model, research parks may augment their three traditional roles of discovery, invention, and commercialization, by taking on a fourth function, assessment.

Technology assessment is of clear value to all four "spheres" of Fig. 3, the public, the private, the scientific and the lay. TA therefore can carry science parks toward the resolution of their identity anxiety.

Research parks can augment their missions as knowledge precursors: Inventing, commercializing, and assessing technology, and exchanging TA results with other parks, using DGIF as a clearing-house. At the practical level, assessment may follow the model of reciprocal pro bono peer review of academic papers, with each park setting aside a fraction of budget for TA discussion and research, possibly with financial assistance from international agencies.

This recommendation is not without its difficulties. Science parks in developing nations may face local political difficulties as well as the additional challenge of championing scientific method and technology entrepreneurship/commercialization in a surrounding culture that finds these activities alien or even objectionable. Baltimore et al [1] remark, "At the dawn of the recombinant DNA era, the most important lesson learned was that public trust in science ultimately begins with and requires ongoing transparency and open discussion." When science parks conduct participatory TA, their difficulties with the prevailing national culture may ease.

REFERENCES

[1] Baltimore, D. Berg, P., Botchan, M., Carroll, D., Charo, R.A., Church, G., Corn, J.E., Daley, G.Q., Doudna, J.A., Fenner, M., Greely, H.T., Jinek, M., Martin, G.S., Penhoet, E., Puck, J., Sternberg, S.H., Weissman, J.S. and Yamamoto, K.R., "A prudent path forward for genomic engineering and germline gene modification," *Science* 348(6230) 3, pp. 36-38, 2015.

[2] Battelle Technology Partnership Practice, "Driving regional innovation and growth: The 2012 survey of North American University Research Parks", Retrieved 11/5/15 https://aurp.memberclicks.net/assets/documents/aurp_batelllereportv2.pdf

[3] Brooks H.; "The state of the art: technology assessment as a process," *International Social Science Journal*, 25(3), pp.247-256, 1973.

[4] Brune, W. H, "The ozone story: A model for addressing climate change?",Retrieved 11/11/15 http://doi.org/10.1177/0096340214563685

[5] Coates, V., Farooque, M., Klavans, R., Lapid, K., Linstone, H.A., Pistorius, C., and Porter, A.L. 2001. On the future of technological forecasting. *Technological Forecasting and Social Change,* 67(1), pp.1–17.

[6] Dierdonck R. V., K. Debackere and M. A. Rappa, "An assessment of science and technology parks: towards a better understanding of their role in the emergence of new technologies", Retrieved 11/11/15 http://hdl.handle.net/1721.1/46889

[7] Eijndhoven, J.C.M.V.; "Technology assessment: Product or process?," *Technological Forecasting and Social Change,* vol.54 (2), pp. 269-286, 1997.

[8] Gulbrandsen, M.; (2011) "Research institutes as hybrid organizations: Central challenges to their legitimacy," *Policy Sciences*, 44(3), pp. 215–230, 2011.

[9] International Association for Impact Assessment, "Technology assessment 12 mar 2010 Bridget-IAIAhq", Retrieved 11/11/15 http://iaia.org/iaiawiki/techassess.ashx

[10] Keller J., "Global innovation is facing a slowdown for the best possible reason", Retrieved 12/11/15 http://www.psmag.com/business-economics/on-the-global-innovation-slowdown

[11] Malone, M.S., "The purpose of Silicon Valley", Retrieved 12/11/15 http://www.technologyreview.com/review/534581/the-purpose-of-silicon-valley/

[12] Mathewson, T. G., "UNESCO recommends global monitoring system for ed progress", Retrieved 13/11/15 http://www.educationdive.com/news/unesco-recommends-global-monitoring-system-for-ed-progress/399816/

[13] Moorthy V.S., G. Karam, K.S. Vannice and M.P. Kieny, "Rationale for WHO's new position calling for prompt reporting and public disclosure of interventional clinical trial results", Retrieved 14/11/15 *PLoS Med* 12(4): e1001819. doi:10.1371/journal.pmed.1001819

[14] National Academy of Engineering (NAE), *A Study of Technology Assessment* (1969).

[15] Phillips, F.Y.; "Toward a Sustainable Technopolis," in *Technopolis: Best Practices for Science & Technology Cities*. D.S. Oh and F. Phillips Ed. Springer, 2014.

[16] Porter, A.L., 1995. Technology Assessment. *Impact Assessment*, 13(Summer), pp.135–151. Available at: http://94.23.146.173/ficheros/b3663b2c83bf0b48360e7118e46d4abb.pdf.

[17] Porter, A.L., 2006. Impact assessment methodology is too insular. *Impact Assessment and Project Appraisal*, 24(2), pp.86–88.

[18] Ripin B. and A. Fainberg, "Viewpoint: Bring back the OTA!", Retrieved 11/11/15 http://www.aps.org/publications/apsnews/200108/viewpoint.cfm

[19] Schaffhauser, D., " UNESCO report proposes international measures for monitoring ed progress", Retrieved 11/11/15 http://campustechnology.com/articles/2015/05/26/unesco-report-proposes-international-measures-for-monitoring-ed-progress.aspx

[20] *Scientific American,* "Bring back the OTA", Retrieved 8/11/15 http://www.scientificamerican.com/article/bring-back-the-ota/

[21] State Science & Technology Institute (SSTI), "EDA announces $5M in science and research park development grants", Retrieved 8/11/15 http://ssti.org/blog/eda-announces-5m-science-and-research-park-development-grants

[22] *The New York Times*, "A pill to boost female libido", Retrieved 8/11/15 http://www.nytimes.com/2015/06/12/opinion/a-pill-to-boost-female-libido.html?_r=0

[23] Triebig G., "Implications of latency period between benzene exposure and development of leukemia--a synopsis of literature," *Chemico-Biological Interactions,* vol. 184 (1-2), pp. 26–29, 2010.

[24] UNESCO Institute for Statistics, "Post-2015 education indicators", Retrieved 11/11/15 World Wide Web. http://www.uis.unesco.org/Education/Pages/post-2015-education-indicators.aspx

[25] U.S. Economic Development Administration, "Fiscal year 2013 annual report", Retrieved 8/11/15 https://aurp.memberclicks.net/assets/documents/aurp_batelllereportv2.pdf

[26] Wad A. and M. Radnor; "Technology assessment: Review and implications for developing countries," in *Science Policy Studies and Documents*, A. Wed and M. Radnor, Eds. The United Nations, 1984.

[27] Wadhwa V., "Come on, Silicon Valley, you can do better than this" *Washington Post*. Retrieved 1/11/15 World Wide Web, http://www.washingtonpost.com/blogs/innovations/wp/2014/06/23/come-on-silicon-valley-you-can-do-better-than-this

[28] Wexler, C., "Bring Back the Office of Technology Assessment", *New York Times.* Retrieved 1/11/15 World wide Web http://www.nytimes.com/roomfordebate/2015/05/28/scientists-curbing-the-ethical-use-of-science/bring-back-the-office-of-technology-assessment