

Anticipating Techno-Economic Fallout: Purpose-Driven Socio-Technical Innovation

THIS special issue is dedicated to several themes encompassing techno-economics and socio-technical innovation as related to public interest technology (PIT). The techno-economic paradigm underpins the innovation-based theory of economic and societal development [item 1) in the Appendix]. In the June edition of the IEEE TRANSACTIONS ON TECHNOLOGY AND SOCIETY, Abbas *et al.* [item 2) in the Appendix] wrote about the motivation for invention and innovation. Certainly, we acknowledge a shift from a mechanistic approach to an evolutionary approach in economics, but believe there is yet one more shift that is required, one that involves injecting purpose-driven socio-technical co-design for the proliferation of PIT. It is in the acknowledgment that “societal development” should be the dominant aspect when considering the techno-economic paradigm, which in the first instance requires an evaluation of the manner in which we perceive production and consumption.

I. PRODUCTION, OBSOLESCENCE, AND THE THROW-AWAY GENERATION

The world has been dedicated to maximizing efficiency and scale of production since at least the beginning of the Industrial Revolution, and we have maintained allegiance for over 260 years through a sequence of economic growth cycles [item 3) in the Appendix]. Where once we were accustomed to scenes from large industrial manufacturing plants that incorporated large numbers of workers, each dedicated to their specialized task, gradually throughout the decades we have seen machines introduced on the factory floor, automating large parts of the manufacturing process. What this means is that we can now produce even more, continuously, for less. Commodities are at an all-time high, and we are promised that even more is coming with billions upon billions of smart devices being released in the market and ultimately permeating every aspect of our lives. This momentum thus does not seem to be slowing. To where might this treadmill of production take us? And why are we preoccupied with “things”? The accumulation of things, the need to pay for things, the need to own things, particularly when these very things rapidly become obsolete.

In some instances, we can refer to deliberate corporate strategies as *planned obsolescence*, where the objective is to encourage continual upgrades of things every 6–12 months, providing sufficient time for the design and development of a new product, thereby kicking off yet another S-curve in

a business. While digital artifacts can be infinitely reproduced, physical goods require significant resources, and these resources are finite. Even the means of production are finite. And with the increasing pressures to produce more and in less time, we risk compromising on quality or on the care of the worker and other operational stakeholders. This inevitably has a flow-on effect at the application side of the process and, therefore, on the users and at times, society at large. This interplay between production and application is like a dance of *give and take* at scale. It is like a flash mob that gathers in a shopping mall, unsuspectingly sprouts up with stealth, captures the attention of the public, and creates a spectacle for the onlookers, who finally succumb to join in and partake of the experience. But there is nothing unsuspecting about today’s material marvels. They are deliberate, and they have meticulously worked out how and why people dance [item 4) in the Appendix].

This is all the more exacerbated by the contactless and frictionless taglines we read about; the influence of targeted marketing and persuasive systems that urge us to get the next deal, allied with the ease which we can purchase items through a simple tap on a smartphone or asking “Alexa” to order another item for us. This immersive cyber–physical shopping mall has significantly reduced the effort needed for consumers to access and purchase goods and have them delivered to their doorstep. The contactless and frictionless just means we are accumulating more, and then tossing things away when they malfunction or when we seek the latest upgrade, synonymous with a throw-away generation that thinks sustainability but does not live it in their action [items 5) in the Appendix]. The right to repair movement [item 7) in the Appendix] challenges the “resistance is futile” meme [item 6) in the Appendix], calling for a sober response to upgrades and openness, giving back some power and control to the people.

II. TECHNO-ECONOMIC FALLOUT

The papers in this special issue emphasize that if we maintain this current course when designing and developing products; that is, with a heavy focus on producing technological artifacts for the masses, we may find ourselves with significant, continuous, and spiraling unintended consequences. These consequences can be described as analogous to *network fallout* in the context of exaggerating the techno-economics [item 8) in the Appendix] at the expense of the individual person or the social aspects. Fallout, with respect to a “nuclear fallout,” refers to the lingering radioactive material in the form of dust and ash that is thrust into the atmosphere and literally begins to *fall out* of the sky after the initial explosion and shock wave [item 9) in the Appendix].

The greater the size of the bomb, and the greater the altitude from which it is detonated, the greater the footprint of the fallout. We can speak of local and global fallout, in addition to short-term and long-term effects of fallout. The first impact after a bomb has been dropped is that of the lethal carcinogenic material with a long half-life; and the second impact is the radioactive dust that is released post-explosion with a short half-life [item 10) in the Appendix]. The first impact is deadly for all those directly affected; and the second impact acts to mutate, maim, and alter the natural course of things [item 11) in the Appendix].

The techno-economic paradigm built on systems of innovation seeks to maximize return on investment (ROI) for shareholders as the number one aim of a business' existence. We suggest that the aim, however, should not be in blindly producing yet another shiny gadget but in the nuanced and meaningful design and development of products and services that humans need for survival and flourishing. When we taught commerce to grade 9 and 10 students in the 1990s, there was a clear distinction between needs and wants. *Needs*, that is necessities, were those things like food, drinking water, shelter, and clean air, and *wants* were things that were nice to have but we could do without. Today, because of our accelerated pace of innovation and change, some things or wants have come to be considered as necessities. To a worker in a Western society who is a professional, seeking to live without a smartphone, email address, and even a portable device like a laptop is near impossible. Somehow our technological innovations have pervaded our lives to become default needs. But how many of these gadgets can we have? What do we do with all of those machines that are obsolete? What is the societal and environmental impact of frenetic consumerization of digital technologies? And if we anticipate an even greater explosion of personal devices, what might that mean in terms of fallout? Indeed, the fallout of nearly 40 years of personal computing will be felt for centuries to come unless we deliberately and mindfully evaluate our choices moving forward, and avoid an apathetic stance toward those developing nations that are taking on our e-waste in the name of recycling, landfills, trade agreements, and more [item 12) in the Appendix].

III. PURPOSE-DRIVEN SOCIO-TECHNICAL INNOVATION

Our innovations must be purpose-driven, meaningful, and cognizant of the unintended consequences during the initial design phases. Furthermore, radical innovations must be scrutinized in view of our long-term survival. The inequalities seem ever present despite our unfulfilled aim to satisfy the UN Sustainable Development Goals by 2030, which is imminently encroaching. And it appears that our priorities are often misaligned; as some of us race to produce the next smartphone, a great number of people are still struggling to gain access to drinkable water. We acknowledge there is no utopia but surely resources, both human and other, should be channeled toward that which will sustain species on Earth for longer. We should seek biodiversity and healthy ecosystems where species thrive and are not threatened by extinction or the unintended impacts of technology and human settlement. It is at this point that we should appraise what kinds of innovations we want to build to fulfill these objectives, including assessing their

potential reach. This ensures that we do not forfeit the benefits of technological innovations, but also do not make demands or impose them on people who do not want or need them.

In this editorial, we are pointing to the need for purpose-driven socio-technical innovation, whereby we accentuate the “purpose-driven” element during technology design, development, and innovation processes. But we must first ask ourselves, what constitutes “purposeful” and purposeful for whom? The rich and powerful, the poor, the “ordinary” person? It is here that we stop to think about communities that have suffered injustice and how we might rectify and overcome these injustices, which seem to be perpetuating based on discriminating factors like where people were born, the color of their skin, their education levels, their religious affiliation, among many other factors. We are seeking to emphasize public interest technologies, again, stressing the need to carefully design socio-technical systems that will empower communities rather than exclusively support a privately owned, self-fulfilling advertising model on a search engine, where the human is the product.

A practical step forward in this regard is the awareness that communities are not privately owned, and should not be externally manipulated or defined by a turn-key product or solution fueled by algorithmic bias [item 13) in the Appendix]. Furthermore, we must recognize that the fallout from the techno-economic machine, preoccupied with treadmills of production, has long lasting impacts on the health of future generations. This should be enough of an impetus for changing our course. This change must come in the form of a new approach; an innovative model of business and engagement that acknowledges the importance of relationships, care, and hope in socio-technical processes. This special issue incorporates themes that touch on aspects of the techno-economic fallout in the context of innovations that simply are instituted to propel systems of production, rather than focus on end-user application, and societal progression and flourishing. Some of these papers raise a variety of sensitive issues in context, demonstrating an anticipatory approach to exploring shortcomings in the design and development of new technologies, while proposing ways in which to overcome them.

IV. OVERVIEW OF ACCEPTED PAPERS

This special issue is composed of seven papers. It is important to note that the majority of these papers had their origin at the *IEEE International Symposium on Technology and Society*, held virtually in November 2020. The first brief paper, titled “Dynamics in Data Privacy and Sharing Economics,” is presented by four industry-based authors led by Shubhadip Ray, who are engaged with IBM Global Services and Wunderman Thompson. The paper stresses that as we continuously consume products and services, as well as produce products and services for others to consume, we must beware of inherent bias particularly paying close attention to the paradox of personalization and privacy with an alignment on trust. The second paper also addresses the importance of privacy and ethical considerations with an emphasis on wastewater monitoring. This paper is written by a transdisciplinary team of six researchers from biodesign at Arizona State University led by Danielle Jacobs who traverse the very complex societal and ethical questions raised by

the analysis of municipal wastewater for better understanding emerging epidemiological trends, including human and disease migration. Continuing on the theme of data openness and privacy is the third paper by psychologist Jordan Schoenherr from Carleton University in Canada. Schoenherr's paper studies the diffusion and adoption of surveillance technologies that have increased significantly in the past few decades, while at the same time, noting that the cost of sensors, data storage, and algorithms have been markedly reduced. He questions the fate of social norms as he explores the associations between data openness practices, privacy norms, and conformity bias which he calls *cultural tightness*.

The fourth paper is a detailed paper, titled "Face Morphing Attack Generation & Detection: A Comprehensive Survey," written by the authors from the Norwegian University of Science and Technology specializing in information security, led by Sushma Venkatesh. The paper focuses on face recognition for real-time applications, especially in the context of e-passports, disclosing successful morphing attacks to subvert a facial recognition system at an automatic border control gate by presenting an e-passport that is obtained based on a morphed face image. The authors stress the importance of vulnerability assessments, and performance evaluation metrics in their comprehensive survey that need to be addressed in the evolving field of biometrics. The fifth paper, titled "Clickbait—Trust and Credibility of Digital News," continues the theme of a different kind of attack, that of the somewhat subtle clickbait in news. The authors, Vivek Kaushal and Kavita Vemuri, are with the Perception Engineering Group at the Cognitive Sciences Lab at IIIT Hyderabad in India, and look at the incidence and impact of clickbait headlines that significantly reduce the credibility of news items. In this manuscript, a correlation between age and propensity for clickbait was observed. This paper furthermore indirectly points to the underlying thesis of this editorial; that more of something is not necessarily better, and that at least metaphorically the production of yet more goods (that society might not really need) is a form of clickbait in itself. Paper six is a brief paper written by self-identified Mexican-American sociologist Soraya Cardenas of Cascadia College who wrote an autoethnography of her sociological imagination with respect to the Theory of the Treadmill of Production [items 14) and 15) in the Appendix]. Cardenas' work, although a brief paper, had a profound impact on this editorial team, especially with respect to marginalized people and human rights.

The final paper in this special issue is titled "Attention Enhancing Technology: A New Dimension in the Design of Effective Wellbeing Apps" and is an exemplar paper that identifies a problem, and works actively to overcome it by acknowledging that new technologies are here to stay, so we best consider what values we wish to imbue in them, and then go about deliberately incorporating those values into the product design and development. The paper is written by Leon Wiederkehr and Jeremy Pitt from the Department of Electrical and Electronic Engineering at Imperial College London, Thomas Dannhauser from the Neuropsychiatry Department at Smart Start Minds, and Katarzyna Bruzda from the Graphic Design Department, University of the Arts London. This transdisciplinary team comes together to address excessive phone use that can have

negative impacts on mental health and productivity. The team proposes a set of design principles for wellbeing apps that brings together elements of value-sensitive design from interaction design and behavioral models from psychology.

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APPENDIX RELATED WORK

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