EDITORIAL

THE SOCIAL AND ETHICAL ASPECTS OF PROGRESS IN THE NEW AND EMERGING SCIENCES AND TECHNOLOGIES

Scientific and technological development in many fields has become increasingly rapid over the past two decades. Thus, in the middle of the second decade of the 21 Century, the New and Emerging Sciences and Technologies (NEST) are revolutionizing our world and increasingly transforming individual and social life by providing both a deeper understanding of the grammar of nature as well as numerous opportunities for social and economic progress. The convergence of new knowledge and technological applications in the broad domains of nanotechnology, biotechnology, information technology and cognitive science is supporting the emergence of deeply transformative technologies and profound scientific discoveries (Roco and Bainbridge, 2003). Many of these NEST are enabling sciences and technologies, meaning that they have a wide range of applications in many fields, from medicine, through industry to consumer devices, and they also build the foundations for further scientific and technological development. The trends of increasing global interconnectedness, again in no small part spurred by NEST development, have enabled the rapid exchange of information and goods, as well as cooperation and collaboration across large spatial and temporal distances. In such a socioeconomic context, NEST have become inextricably connected with national development, competitiveness and growth, making the paradigm of innovation, especially technological innovation, one of the key national policy goals on a global scale (EC, 2011; West, 2011). In this way, the applications of NEST have become the key transformative drivers in practically all contemporary societies and their subsystems, including not just industry and economy, but also sociocultural patterns and trends. Therefore, we are no longer talking just about innovation economies (Canton, 2005),[1] but about innovation societies.

Greater knowledge and understanding of the functioning of complex biological systems at ever smaller scales, and the development of the tools to modify or recreate them *ex vivo*, no longer influence the functioning and behavior of living beings only extraneously, but increasingly open up the

[1] *Originally conceived by Joseph Schumpeter (1947/2010) as characterized by technological change, entrepreneurship and institutional evolution.*

possibility of intervention and design with the goal of modifying and even engineering their basic capabilities *in vivo*. Such possibilities for rational (re)design are no longer limited solely to the domains of plants, animals and microorganisms, but are now extending to the enhancement (expansion) of basic human capabilities through direct interventions in the human body, especially the brain (Coenen et al., 2009; Savulescu and Bostrom, 2009). Several NEST thus promise to exert profound transformative impacts on humans, societies and nature. For example, synthetic biology promises to enable the (re)engineering of both microbial and animal cells in order to create cell factories for the production of chemicals, fuels or medicines, biological devices for waste processing and environmental remediation, or even to create expanded or new functionalities and capabilities in whole organisms (Church and Regis, 2012). Progress in neuroscience and neurotechnology is already resulting in attempts by individuals and groups in various populations to enhance their cognitive capabilities through the use of psychopharmaceuticals and brain stimulation devices (Kadosh, 2014; Pustovrh and Mali, 2014). Brain research and simulation together with various other (neuro)-technologies open the prospects for the treatment of various diseases and disorders, understanding, mapping and manipulating the brain mechanisms of various mental capabilities and states, as well as the possibility of producing software, hardware or hybrid systems with brain-like intelligence (HBP, 2012) or even surpassing human-level intelligence (Kurzweil, 2012).

As the impacts of NEST applications become increasingly powerful and widespread, through technologies and tools of growing capabilities and their rapid adoption through global market systems, their possible negative consequences can translate into risks of increasing scope and magnitude (Pustovrh, 2010). In this way, given both the strong technological dependence and focus on innovation and development, anthropogenic risks have become an inherent feature of modern societies. Given that there are numerous NEST applications, connected both with security and safety issues, that is, with intended hostile and unintended negative consequences, which could present global catastrophic risks (Bostrom and Sandberg, 2008), there are strong incentives to prevent or at least minimize the risks that are increasing together with NEST capabilities, and which are firmly embedded in the systems and structures of modern civilization.

Given that NEST could have profound negative impacts on the environment, health and safety, as well as deep transformative influences on nature, society and the individual, both on the regional and possibly global scale, there have been calls to broadly relinquish or selectively ban specific lines of NEST research and development (Fukuyama, 2002; McKibben, 2004). But as NEST applications are not only a source of risks, but also a powerful tool to address pressing societal problems, such as the contemporary grand

challenges of aging populations, energy, food and water, climate change, pandemics and societal security (LD, 2009), which are the (by)product of modern societies, it is hard to imagine how the level of sociocultural and technoscientific complexity the human civilization has achieved could be surpassed or at least retained without them. And although human beings tend to be change averse on the one hand, the striving to continually surpass the limitations of the human condition, especially through scientific and technological means, has become a constant of modern civilization, most strongly reflected in trends aimed at enhancing "normal" or "average" human capabilities (Fuller, 2013). Further, NEST applications will likely be crucial in ensuring survival and adaptation in light of not only anthropogenic risks, but also the risks and adverse environmental changes of nonanthropogenic origin, that is, dangers generated by (bio)physical systems without human influence.

If relinquishment and bans are not a viable option despite large potential risks and adverse societal impacts, then there is a strong societal need for the proper management or governance of NEST development and implementation, which would ideally take place before commercialization and ensure that the positive potentials are realized, while the risks and negative impacts are minimized and mitigated. In this way, the focus is no longer solely on hard, technical risk assessments of environmental, health and safety impacts (EHS), but also on the wider, sometimes global impacts on individual and collective sociocultural patterns and trends, trying to analyze both potentially negative and more widely desirable outcomes. Such approaches tend to take a longer-term, systemic view of the developmental trajectories of contemporary sociotechnological systems, regarding their internal evolution as well as their interaction with the wider biosphere.

Such practices of examining the ethical, legal and societal implications of technology, their risk and economic assessment, foresight or even anticipatory governance, are no longer focused only on risks, but also on the notion of responsibility, at the level of the research, the development process and the wider society. Faced with the challenges of being dependent on the innovative potentials of NEST on the one hand and needing to ensure societally desirable and acceptable products and outcomes on the other, international policy approaches that would ensure "responsible research and innovation" (von Schomberg, 2012) or "prudently vigilant" (PCSBI, 2010) governance of NEST, have been adopted in the EU and the US respectively. Ultimately, such approaches would enable the proper and beneficial integration of NEST applications into society, while simultaneously giving a wide range of stakeholders and the public some type of say in the informing and shaping of science and technology policies, especially in addressing pressing societal needs and challenges.

Developments in NEST have thus inspired promises of great benefits, vastly expanded capabilities and solutions for grand societal challenges, and they have also raised fears of wide-ranging risks and negative impacts on individuals, groups and societies. For example, most European countries (including Slovenia) are still faced with wide consensual divides between knowledge producers, users and citizens. Many innovative applications of NEST lack significant public support because the possible benefits and risks of NEST are not presented in balanced ways. Namely, citizens and consumers seem to be fixated on the risks and uncertainties of the progress in new technologies while commonly underestimating the socio-economic opportunities and possible benefits of future scientific and technological progress. Here, the role of media cannot be overlooked. As Dorothy Nelkin points out, "...for most people the reality of new science and technology is what they read in the press" (Nelkin, 1987: 2). In the last few decades, a lot of other STS studies have found that when a specific issue receives significant news coverage, that issue also gains increasing priority in the public's mind (Groboljšek and Mali, 2012).

Despite such uncertainties and ambiguities, it is clear that NEST will have profound impacts over the coming decades, both positive and negative, at various levels, spurring rapid, pervasive changes in an interlinked world. The social sciences and humanities (SSH) have traditionally focused both on examining, explaining and even predicting individual and social changes and trends, and critically examining new, especially reductionist approaches, explanations and trends. So what can or should be their role in this complex, modern sociotechnological context, and what are the challenges facing them? On the one hand, SSH can offer insights on how NEST developments might impact society and the biosphere, analyze trends, patterns and discourses that are emerging from such developments, changes in fundamental issues such as human nature, the good life, societal goals and values, as well as offer a (critical, though constructive) perspective on the implications of their adoption.

On the other hand, NEST provide tools and insights that SSH could and probably need to incorporate in order to arrive at better theories and explanatory models, especially since NEST increasingly transgress and dissolve traditional boundaries, demarcations, concepts and approaches. Such developments pose complex challenges and require an interdisciplinary perspective and also increased collaboration between researchers from various disciplines and backgrounds.

In this volume, we examine only some of the numerous issues and challenges stemming from this complex topic, such as new risk assessment frameworks for NEST, the ethical, legal and societal implications of new NEST applications and trends, the challenges of NEST for SSH, novel

epistemological, expert knowledge and collaborative practice implications, and challenges for the governance and incorporation of NEST into societal (sub)systems. The contributors are established experts in various fields within the SSH and their contributions predominantly focus on institutional and policy contexts and factors, and on aspects of specific NEST fields, such as synthetic biology, nanotechnology, neuroscience and human enhancement technologies.

But the issues addressed in the contributions are not only instructive for readers in showing the recent challenges posed by the tremendous progress of NEST, they also lead us to re-think the role and function of future technological scenarios and visions. The ethical, social and legal questions of synthetic biology, neurotechnology, nanotechnology and human enhancement technologies need to be discussed not only within the present temporal context, but as part of an ongoing future oriented co-evolution process among science, technology and society. The magnitude and speed of NEST progress is thus encouraging theoretical reflections on the role of new technologies in the building of desirable future conditions for individual and social life. On the other hand, our engagement with the future also requires a lot of reflexivity in order to make recent societal actions and practices more articulated and rational. Namely, we can learn a lot about the present by examining our technological visions of the future. To be clear, the precondition for this is avoiding any kind of ideologically-based prejudices about the social, legal and ethical implication of the progress of NEST. The least productive approaches for SSH researchers dealing with the social aspects of NEST are based on fixed ideological positions, which exaggerate a clearly demarcated bipolarity of dystopia and utopia in the interpretation of the impacts of future technological progress.

In order to deal with the potential negative impacts of NEST developments, several mechanisms and institutions have evolved over the past decades that are engaged in efforts to promote (some aspects of) socially responsible science and innovation, including Offices of Technology Assessment (OTAs) and Ethics Advisory Bodies (EABs) (Mali et al., 2012). Such institutions, now established in most European countries, generally perform the tasks of addressing the ethical, legal and societal implications of NEST, and some of them also attempt to engage and deliberate with relevant stakeholders and the wider public on contentious science and technology issues.

In this context, *Alexander Bogner and Helge Torgersen* focus on the institutional mechanisms and practices of OTAs, their development and methods, as well as the modern challenges they face, exemplified through engagement with some of the implications of synthetic biology.

Igor Pribac highlights an aspect of the other key type of institution that

examines various societal, especially ethical issues of NEST, the ethics advisory body, more specifically the national (medical) ethics committee. In his contribution, he focuses on the qualifications of EAB members with different professional backgrounds, and the legitimacy of their role in making ethical decisions concerning new (bio)medical practices and technologies in a national context, based on the values of autonomy, health, and individual and social good.

Christopher Coenen is dealing with transhumanism as a specific ideology and a sociocultural movement which is increasingly influential in recent ethical and societal debates about NEST. He argues that transhumanist ideology is a challenge for the interdisciplinary field of technology assessment and for the humanities. The biggest challenge for the humanities is seen in the fact that transhumanism has always, almost religiously, aspired to dissolve the humanist individual, even long before the latter's theoretical decentering became widespread in academia.

The environmental impacts of older technologies and industrial processes are resulting in regional and even global environmental changes, leading to new policy paradigms for more efficient and less polluting NEST technologies that would ideally replace the former. *Andrej A. Lukšič* examines the concept of the Low-Carbon Society and the way it is being interpreted and implemented by experts and political decision-makers through the lens of critical ecological science, highlighting some important issues for green policies and the societal debate in the national context.

The notion of responsibility is being increasingly introduced in the debates on how to properly govern NEST, although the meaning and role of such a concept is still far from clear. Nevertheless, the notion has already become an important element of the science and technology policy and governance discourse, especially in Europe, and is strongly connected with the concepts of sustainability, ethics and inclusion. *Simone Arnaldi* discusses the use of the term in the context of EU policy and NEST fields, as well as its conceptualization and (historically) changing nature in the relationship between science and society, while showing that the notion in such discussions is not necessarily a new one.

Neuroscientific research has recently come to be regarded as one of the most promising and important NEST fields, with the human brain/mind as one of the key research targets of the new millennium. With the nineties of the previous century designated as the Decade of the Brain (Jones et al., 1999), and recent major projects such as the BRAIN initiative (Markoff, 2014) in the US and the EU Future and Emerging Technologies flagship Human Brain Project (2012), the impact of brain research will have major implications for practically all NEST fields, as well as science, industry and society in general. But the rapid spread of neuroscientific research to other

fields also leads to simplified explanations for complex phenomena, which are nonetheless quick to garner media headlines, echoing previous trends from genome research in simplistic stories such as "gene for X discovered!". *Sebastjan Vörös and Olga Markič* take a critical look at the impacts of the neuroscientific revolution and its spread into SSH, focusing especially on simplified assumptions, hypotheses and methodologies, calling for more rigorous epistemological and conceptual foundations in order to avoid simplistic neuroscientific explanations and interpretations of complex phenomena.

The increasing ability to understand and eventually manipulate capabilities of healthy people also allows their potential enhancement or expansion through direct technological interventions into the body. Attempts to enhance the cognitive functions of the human brain are an especially prominent area both of research and of practice, especially in modern societies that value and reward increased productivity and enhanced capabilities (Hildt and Franke, 2013; Lynch et al., 2014). *Toni Pustovrh* focuses on an empirical examination of the trend of using prescription psychopharmaceutical stimulants in order to enhance concentration, memory and wakefulness outside of a medical treatment context. Specifically, he presents the results of a survey conducted among undergraduate students at the University of Ljubljana regarding their experiences and attitudes towards pharmaceutical cognitive enhancement in a national context. He further provides several contextual interpretations of the tangible trend, suggesting how societies might want to address it.

Synthetic biology is currently seen as one of the most promising and economically important NEST by many experts and organizations, with implications for industry, medicine, bioeconomy, environmental remediation and governance, as well as fundamental concepts such as life, biology, artificiality and creation (Chruch and Regis, 2012; OECD, 2014). *Franc Mali and Anton Kramberger* examine some implications of the field, including issues of risks and intellectual property rights, which represent some of the crucial discussion point for understanding the wider ethical, legal and social aspects not just in synthetic biology, but in most NEST.

In the complex and changing modern scientific landscape, new NEST as well as their examination requires new, increasingly inter- and transdisciplinary types of scientific collaboration. While many authors point to the importance of fostering such collaboration in promoting innovation and responsible development, it is still largely unclear to what extent and in which forms such practices already exists. *Blanka Groboljšek and her coauthors* attempt to determine whether there are important differences in research collaboration practices between scientific disciplines that predominantly function in the context of the "Mode 1" production of knowledge

and the disciplines more committed to "Mode 2". The empirical study of the different types of scientific collaborations has been performed on the sample of Slovenian scientists.

As we have attempted to show, NEST as well as their scientific and societal context open up numerous challenges and issues. We hope that this thematic issue will highlight some of the important questions and especially raise new ones, pointing to further avenues of research and examination, which will lead to greater security and resilience of complex modern societies that are increasingly dependent on their technoscientific foundations.

Toni Pustovrh, Franc Mali
Guest Editors

BIBLIOGRAPHY

Bostrom, Nick and Milan M. Ćirković (eds.) (2008): Global Catastrophic Risks. Oxford: Oxford University Press.

Canton, James (2005): NBIC Convergent Technologies and the Innovation Economy: Challenges and Opportunities for the 21st Century. In William Sims Bainbridge and Mihail C. Roco (eds.), Managing Nano-Bio-Info-Cogno Innovations: Converging Technologies in Society, 33–45. Dordrecht: Springer.

Church, George C. and Ed Regis (2012): Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves. NY: Basic Books.

Coenen, Christopher, Mirjam Schuijff, Martijntje Smits, Pim Klaassen, Leonhard Hennen, Michael Rader and Gregor Wolbring (2009): Human Enhancement. Brussels: European Parliament, DG Internal Policies STOA.

European Commission (2011): Europe 2020 Flagship Initiative Innovation Union SEC (2010) 1161. Luxembourg: Publications Office of the European Union.

Fukuyama, Francis (2002): Our Posthuman Future: Consequences of the Biotechnology Revolution. London: Profile Books Ltd.

Fuller, Steve (2013): Preparing for Life in Humanity 2.0. Palgrave Macmillan.

Groboljšek, Blanka and Franc Mali (2012): Daily Newspapers' Views on Nanotechnology in Slovenia. Science Communication 34 (1): 30–56.

HBP-PS Consortium (2012): The Human Brain Project: A Report to the European Commission. HBP-PS Consortium: Lausanne.

Hildt, Elizabeth and Andreas G. Franke (eds.) (2013): Cognitive Enhancement: An Interdisciplinary Perspective (Trends in Augmentation of Human Performance), Springer.

Jones, Edward G. and Lorne M. Mendell (1999): Assessing the Decade of the Brain. Science (American Association for the Advancement of Science) 284 (5415): 739.

Kadosh, Roi Cohen (2014): The Stimulated Brain: Cognitive Enhancement Using Non-Invasive Brain Stimulation. Academic Press.

Kurzweil, Ray (2012): How to Create a Mind: The Secret of Human Thought Revealed. New York: Penguin Group.

Lund Declaration (2009): Available on http://www.vr.se/download/18.7dac901212646d84fd38000336/, 27th June 2014.

Lynch, Gary, Linda Palmer and Christine Gall (2014): The Likelihood of Cognitive Enhancement. Amazon Digital Services, Inc.

Mali, Franc, Toni Pustovrh, Blanka Groboljšek, Christopher Coenen (2012): National Ethics Advisory Bodies in the Emerging Landscape of Responsible Research and Innovation. Nanoethics 6 (3): 167–184.

Markoff, John (2013): Obama Seeking to Boost Study of Human Brain. The New York Times, 17th February 2013. Available on http://www.nytimes.com/2013/02/18/science/project-seeks-to-build-map-of-human-brain.html?hp&_r=0, 27th June 2014.

McKibben, Bill (2004): Enough: Staying Human in an Engineered Age. Holt Paperbacks.

Nelkin, Dorothy (1987): Selling science: How the press covers science and technology. New York, NY: W. H. Freeman.

Organization for Economic Cooperation and Development (2014): Emerging Policy Issues in Synthetic Biology. OECD Publishing.

PCSBI – Presidential Commission for the Study of Bioethical Issues (2010): New Direction: The Ethics of Synthetic Biology and Emerging Technologies. Washington, D. C.

Pustovrh, Toni (2010): The RISC Potential of Converging Technologies. In Lučka Kajfež-Bogataj, Karl H. Müller, Ivan Svetlik and Niko Toš (eds.), Modern RISC-societies: towards a new paradigm for societal evolution, 297–324. Vienna: Echoraum.

Pustovrh, Toni and Franc Mali (2014): Exploring Some Challenges of the Pharmaceutical Cognitive Enhancement Discourse: Users and Policy Recommendations. Neuroethics 7 (2): 137–158.

Roco, Mihail C. and William Sims Bainbridge (eds.) (2003): Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science. Dordrecht: Springer.

Savulescu, Julian ad Nick Bostrom (eds.) (2009): Human Enhancement. New York: Oxford University Press.

Schumpeter, Joseph (1947/2010): Capitalism, Socialism and Democracy. Kessinger Publishing, LLC.

Von Schomberg, Rene (2012): Prospects for Technology Assessment in a framework of Responsible Research and Innovation. In Marc Dusseldorp and Richard Beecroft (eds.), Technikfolgen abschätzen lehren: Bildungspotenziale transdisziplinärer Methoden, 39–61. Wiesbaden: VS Verlag.

West, Darrel M. (2011): Technology and the Innovation Economy. Center for Technology Innovation at BROOKINGS. Available on http://www.brookings.edu/research/papers/2011/10/19-technology-innovation-west, 27th June 2014.