Exponential Innovation and Human Rights

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SCIENCE, TECHNOLOGY, AND GLOBALIZATION

Exponential Innovation and Human Rights

Implications for Science and Technology Diplomacy

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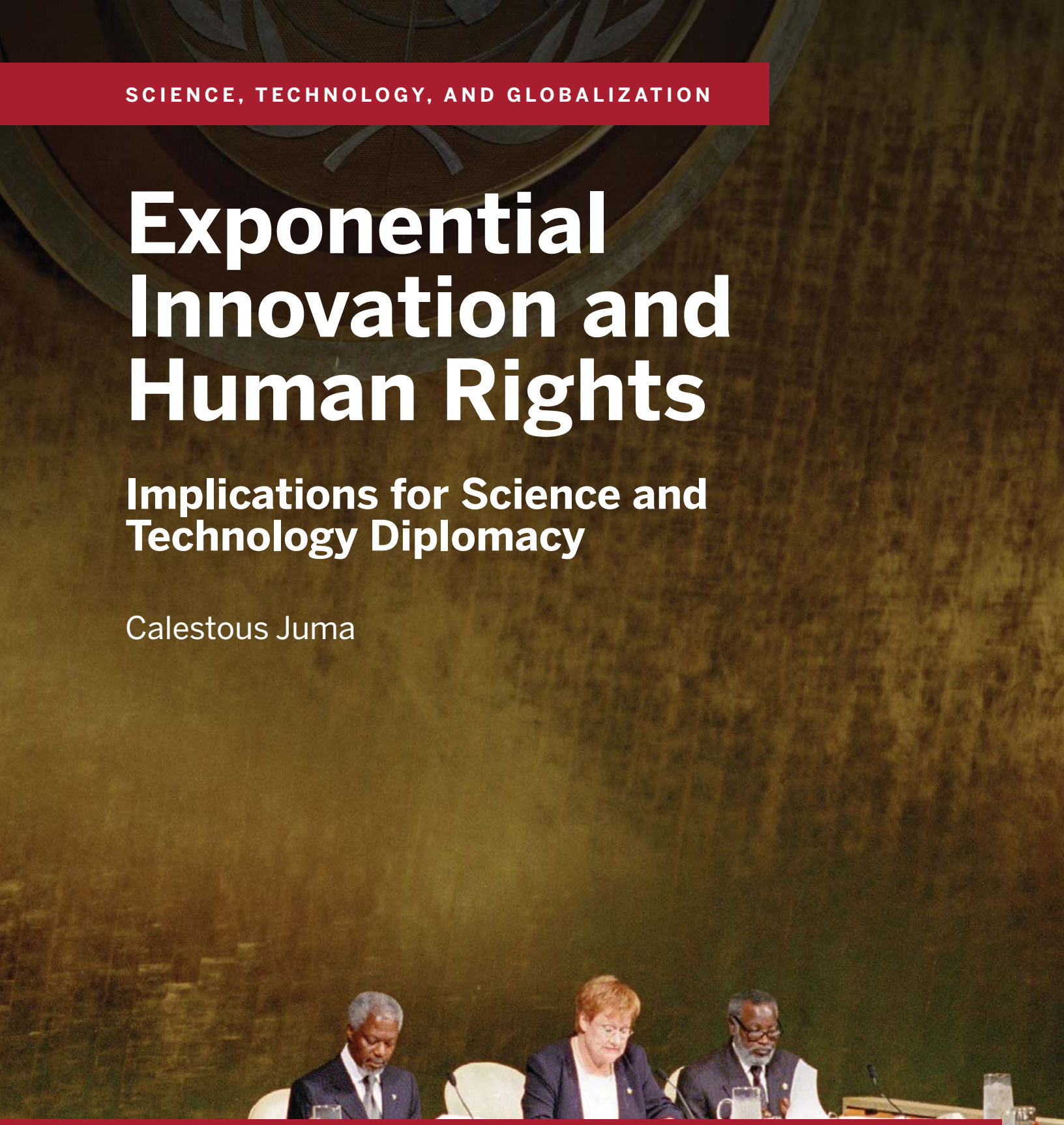

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Cover photo: The Opening Session of UN's Millennium Summit, September 6, 2000. Presiding over the meeting are (left to right): Secretary-General Kofi Annan, and Co-chairs of the Summit, Tarja Halonen of Finland, and Sam Nujoma of Namibia. (UN Photo/Eskinder Debebe)

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Abstract

The international community has historically maintained hope that advances in science and technology offer humanity a wide range of options for improving its well-being. Recently anxieties arising from rapid advancement in science and technology and the emergence of new global business models have re-opened debates on the relations between exponential innovation and human rights. The search for inclusive innovation models has led to the need to rethink traditional views about concepts such as "technology transfer" that continue to underpin international negotiations, especially under the United Nations (UN). This paper explores these themes and proposes alternative ways for emerging economies to expand their human potential without undue reliance on the one-way flow of scientific and technological knowledge from the industrialized countries. It calls on strengthening international science and technology advice, especially in the UN Secretariat, to help support more constructive discussions on the interactions between innovation and human rights.

About the Author

Calestous Juma was Professor of the Practice of International Development at Harvard Kennedy School and director of the Science, Technology, and Globalization Project at the School's Belfer Center for Science and International Affairs. He co-chaired the High-Level Panel on Emerging Technologies established by the Chairperson of the African Union.

Juma was elected to several prestigious scientific academies including the Royal Society of London, the US National Academy of Sciences, the World Academy of Sciences (TWAS), the UK Royal Academy of Engineering, and the African Academy of Sciences. He was named four times as one of the 100 most influential Africans by the *New African* magazine. In 2015 he was named by Scientific American as one of the world's 100 most influential people in biotechnology.

Juma was the first permanent Executive Secretary of the UN Convention on Biological Diversity and founding Executive Director of the African Centre for Technology Studies in Nairobi. He was Chancellor of the University of Guyana and member of the selection jury of the Queen Elizabeth Prize for Engineering. He also served on the board of The Nature Conservancy.

Juma held a DPhil in science and technology policy studies from the University of Sussex (UK) and has received several international awards and honorary degrees for his work on the application of science and technology for sustainable development. He authored *The New Harvest: Agricultural Innovation in Africa* (2015) and *Innovation and Its Enemies: Why People Resist New Technologies* (2016). His forthcoming books include *Emergent Africa: Evolution of Regional Economic Integration* (with Francis Mangeni); *A New Culture of Innovation: Technology, Entrepreneurship and Prosperity*; and *Game Over? Science and Ethics of Biological Extinctions in Africa*. He passed away on December 15, 2017.

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The Opening Session of UN's Millennium Summit, September 6, 2000. Presiding over the meeting are (left to right): Secretary-General Kofi Annan, and Co-chairs of the Summit, Tarja Halonen of Finland, and Sam Nujoma of Namibia. (UN Photo/Eskinder Debebe)

Introduction[1]

Technological innovation and the politics of global justice are two fields that interact quite extensively in international diplomatic discourse and public debate. Controversial issues, such as accessing essential medicines, reducing greenhouse gases, conserving biological diversity, providing clean energy, and expanding the adoption of green technologies, require answers at the intersection of technological innovation, international diplomacy, and global justice. Our approach is to start off with the broader understanding that justice is rights-based and then proceed to analyze it using a goal-based framework. This brings into sharp focus the relationships between innovation and human rights.

However, it is rare that scholarly work specifically explores the interactions between the two fields.[2] Where such studies exist, they have tended to be too narrow in scope to support the identification of new research frontiers on technological innovation and human rights. As the international community explores new paths to find solutions to grand global challenges, it often encounters novel human rights concerns that need to be addressed. This search will need to review the relevance of concepts such as "technology transfer" from industrialized countries to emerging economies. The emergence of "technology transfer" as a major theme in international diplomacy needs to be placed in the context of broader efforts following World War II to advance development as a

1 This paper draws from the author's forthcoming book, *A Culture of Innovation: Technology, Entrepreneurship and Prosperity*. An earlier version of this paper was prepared for a Research Handbook on Human Rights and Development under the leadership of Professor Stephen Marks of the Program on Human Rights in Development at the Harvard T.H. Chan School of Public Health and Professor Balakrishnan Rajapogal of the Program on Human Rights and Justice at the Massachusetts Institute of Technology. I would like to sincerely thank Professor Ruth Okediji (Harvard Law School) and Dr. Theo Papaioannou (The Open University, UK) for their generosity in sharing the valuable sources that helped me to prepare this paper. I am grateful to Katherine Gordon for her research support during the preparation of this paper and to Kate Bauer for her support in the finalization of the draft.

2 See, for example, Theo Papaioannou, "Technological Innovation, Global Justice and Politics of Development," Progress in Development Studies 11, no. 4 (2011): 321–28; Hans Morten Haugen, *Technology and Human Rights—Friends or Foes? Highlighting Innovations Applying to Natural Resources and Medicine* (Dordrecht, The Netherlands, Republic of Letters Publishing, 2012); Mario Viola de Azevedo Cunha, Norberto Nuno Gomes de Andrade, Lucas Lixinski and Lúcio Tomé Féteira, eds., *New Technologies and Human Rights: Challenges to Regulation* (Farnham, Surrey, UK: Ashgate Publishing Company, 2013); Thérèse Murphy, ed., *New Technologies and Human Rights* (New York: Oxford University Press, 2009); Joseph F. Coats, "Science, Technology, and Human Rights," *Technological Forecasting and Social Change* 40, no. 4 (1991): 389-391.

fundamental right.[3] The persistence of the idea, especially in international negotiations on development, may be a barrier to exploring more creative approaches that could prove helpful in shaping policies on the relationships between technological innovation and human rights.

The aim of this paper is to analyze the evolutionary and dynamic relationships between technological innovation and human rights and to outline their implications for further research in the context of global development. There is a large body of literature that examines the linkages between human capabilities and human rights. This work, however, has been focused on capabilities as normative constructs, without extending the analysis to technological capabilities. The relationship between human capabilities and technological capabilities remains unexplored in the literature. Our focus should not only be on their interconnections but also on their dynamism and evolutionary development. Generally speaking, if technological capabilities are not just about resources but also about abilities to function in certain ways, then they should be interdependent with human capabilities.

The purpose is to build on the growing body of thought that views development as a human right that is realized through a process of continuous improvement and seeks to explore areas where the concept of capabilities, as developed by Sen, paves the way for analysis on the interconnections between technological innovation and human rights.[4] The starting point for the analysis is that economic transformation is to a large extent an expression of the freedom to innovate and to diffuse the results in the economy.[5] The idea of "development as freedom"[6] takes on a more programmatic focus when viewed from a technological innovation perspective.[7]

3 Fantu Cheru, "Developing Countries and the Right to Development: A Retrospective and Prospective African View," *Third World Quarterly* 37, no. 7: (2016): 1268-1283.

4 Amartya Sen, *Development as Freedom* (New York: Anchorbook, 2000).

5 Giacomo Zanello, Xiaolan Fu, Pierre Mohnen, and Marc Ventresca, "The Creation and Diffusion of Innovation in Developing Countries: A Systematic Literature Review," *Journal of Economic Surveys* 30, no. 5: (2016): 884-912.

6 Ronald C. Tobey, *Technology as Freedom: The New Deal and the Electrical Modernization of the American Home* (Berkeley, CA: University of California Press, 1997).

7 Calestous Juma, "Complexity, Innovation, and Development: Schumpeter Revisited," *Journal of Policy and Complex Systems* 1, No. 1 (2014): 4-21; Ben Martin, "The Evolution of Science Policy and Innovation Studies," *Research Policy* 41, no. 7 (2012): 1219-1239.

The paper has five sections. The first section outlines the grand challenges that will occupy global attention over the remainder of this century. The section focuses on the dynamics of exponential growth in science, technology, and innovation. The second section examines the relations between human rights and technology transfer. It reviews the origins of the two themes and the limitations of the concept of "technology transfer." The third section analyzes the importance of building technological capabilities as part of wider innovation systems in the development process and how this expands the human potential. The fourth section outlines the implications of exponential innovation and technological abundance for human rights. The final section outlines ways to improve the role of science and technology diplomacy in shaping relations between innovation and human rights. It focuses on the role of the UN Secretariat as an example of the importance of intellectual leadership in global innovation governance.

A view of the opening session of the Millennium Summit as Tarja Halonen, Co-chair of the Summit, addresses the Assembly, September 6, 2000. (UN Photo/Eskinder Debebe)

1. Technological abundance and exponential innovation

Advances in science and technology lead directly to open discussions on their implications for human rights. Such issues appear regularly on the agenda of international negotiations in various forums, especially within the framework of the UN. An example of such emerging science and technology diplomacy concern is the use of artificial intelligence and autonomous weapons in warfare and calls to ban their application.[8]

Other emerging areas of concern include the long-term implications of the application of artificial intelligence and machine learning for employment.[9] International discussions on this matter are raising new human rights questions that directly impinge on issues such as equity and ownership. The global nature of current industrial production systems has shifted the debate into the international arena. Failure to adequately address some of the critical human rights questions could threaten the prospects of society to derive greater benefits from its creative capabilities and technological innovation.[10] Technological anxiety has taken on new dimensions as large parts of the world move into the virtual economy.

The world faces a number of grand challenges that are going to occupy public attention for the rest of this century. According to the US National Academy of Engineering, these challenges fall into four main categories: sustainability (make solar energy economical, provide energy from fusion, develop carbon sequestration methods, and manage the nitrogen cycle); health (provide access to clean water, engineer better medicines, advance health informatics, and reverse engineer the brain); security (secure cyberspace, prevent nuclear terror, restore and improve urban infrastructure);

8 Thomas W. Simpson and Vincent C. Müller, "Just War and Robots' Killings," *The Philosophical Quarterly*, Vol. 66(263) (2016): pp. 302-322.

9 Andrew McAfee and Erik Brynjofsson, *Machine, Platform, Crowd: Harnessing Our Digital Future* (New York: W.W. Norton & Company, 2017); Vivek Wadhwa and Alex Salkever, *The Driver in the Driverless Car: How our Technology Choices will Shape the Future* (Oakland, CA: Barrett-Koehler Publishers, 2017).

10 Calestous Juma, *Innovation and Its Enemies: Why People Resist New Technologies* (New York, Oxford University Press, 2016).

and life enrichment (enhance virtual reality, advance personalized learning, and engineer the tools for scientific discovery).[11]

The way these challenges are formulated illustrates the growing attention that the international community is placing on finding practical solutions to emerging and persistent global challenges. Current concerns over the balance between technological innovation and human rights will not only persist, but they will become more pervasive. The clean technology debates that are currently underway in the domain of climate change will be extended to many other fields. The lessons learned—whether positive or negative—in the climate regime serve as sources of heuristics for other future debates in other fields.

Two important trends are likely to unfold that will change relationships between technological innovation and human rights. First, the sources of new technologies are widely distributed across the globe and traditional views about "technology transfer" from industrialized to developing countries are only part of a larger picture. There is ample evidence of such trends as emerging markets continue to be sources of new technologies that have global implications. Technology exports from Southeast Asian countries and the extensive trade in industrial products among emerging countries underscore the distributed origin of technology. This will change the debate on human rights and shift attention from demands for technology access to demands for suitable endogenous capabilities as well as the right to enjoy these benefits. This concept is recognized in the Universal Declaration of Human Rights (UDHR) and major human rights treaties, including the International Covenant on Economic, Social and Cultural Rights (ICESCR).[12]

Secondly, technological innovation itself will increasingly be seen as a potential tool for expanding human liberties and strengthening human rights. The widespread use of mobile phones, for example, has shown the extent to which emerging communications technologies help to deepen democracy and enable more people to exercise their rights. This has been done through

11 National Academy of Engineering, *Grand Challenges for Engineering* (Washington, DC: National Academy of Engineering, 2008).

12 Specifically, article 17 of the UDHR and article 15 of the ICESCR. See also Audrey Chapman and Jessica Wyndham, "A Human Right to Science," *Science* 340, no. 6138 (2013): 1291.

using information and telecommunications technologies to foster political discussion and coordinate social movements. There will, of course, be areas where new technologies can be used to undermine human rights, but overall society is most likely to evolve in the direction of greater liberties.[13] Critical concerns about the relationships between technological innovation and human rights are therefore likely to shift to new areas related to key factors that help to enhance human capabilities.

Today's world is dominated by exponential growth in scientific and technological knowledge, diversity of cultural activities, and advances in communications technologies.[14] Similarly, new storage technologies have also ensured that the past can hardly leave us. In cultural terms, it is becoming increasingly difficult to separate the past from the present and the present from the future.

There is widespread awareness of rapid scientific advancements and the availability of scientific and technical knowledge worldwide. This exponential growth feeds on previous advances following inner self-propelling momentum.[15] In fact, the spread of scientific knowledge in society is eroding traditional boundaries between scientists and the general public, requiring changes in the way science and technology advice is provided to governments and other actors.[16]

The exponential growth in technical knowledge is also making it possible to find low-cost, high-technology solutions to persistent problems. These technologies are reshaping the political landscape in unprecedented ways, opening up opportunities to expand rights.[17] These opportunities need to be viewed against the fact that there are aspects of human nature that have hardly evolved and predictably drive society to the brink despite warnings.[18]

13 Amartya Sen, *The Idea of Justice* (New York: Allen Lane, 2009).

14 Ray Kurzweil, *The Singularity in Near: When Humans Transcend Biology* (New York: Penguin Books, 2005); Peter H. Diamandis and Steven Kotler, *Bold: How to Go Big, Create Wealth and Change the World* (New York: Simon and Schuster Paperbacks, 2016).

15 Peter Diamandis and Steven Kotler, *Abundance: The Future Is Better Than You Think* (New York: Basic Books, 2012).

16 Calestous Juma and Y.C. Lee, *Innovation: Applying Knowledge in Development*. (London: Earthscan, 2005): Chapter 9; M.J. Feuer and C.J. Maranto, "Science Advice as Procedural Rationality: Reflections on the National Research Council," *Minerva*,Vol. 48, No. 3, 2010: pp. 259–275.

17 Al Gore, *The Future: Six Drivers of Global Change* (New York: Random House, 2013).

18 Rebecca Costa, *The Watchman's Rattle: A Radical New Theory of Collapse* (Philadelphia, PA: Vanguard Press, 2010).

Advances in science and technology will therefore make it possible for humanity to solve problems that have previously been in the realms of imagination. This is not a deterministic view of society but an observation of the global growth ecology of knowledge and the feasibility of new technical combinations that are elicited by social consciousness. This view would lead to the conclusion that the developing world has the potential to have access to more scientific and technical knowledge than the more advanced countries had in their early stages of industrialization. Indeed, the pace at which latecomer economies such as China have been able to leapfrog in certain technologies underscores the possibilities.[19]

Technological abundance and diversity demands a reformulation of some of the human rights questions that have been addressed in the preceding century. Many of the concerns about access to scientific knowledge were formulated during periods of slow technical advancement and high entry barriers. Today the world faces the opposite problem. In fact, the challenge, as demonstrated by the open access movement and online education, is developing the skills needed to select the most appropriate platform and dealing with new issues related to online rights.[20]

19 Dezhi Chen and Richard Li-Hua, "Modes of Technological Leapfrogging: Five Case Studies from China," *Journal of Engineering and Technology Management* 28, no. 1–2 (2011): 93–108; Keun Lee, Tae Young Park and Rishikesha T. Krishnan, "Catching-up or Leapfrogging in the Indian IT Service Sector: Windows of Opportunity, Path-creating, and Moving up the Value Chain," *Development Policy Review* 32, no. 4 (2014): 495-518.

20 Molly Beutz Land, "Protecting Rights Online," *Yale Journal of International Law* 34 (2009): 1–46.

2. Human rights and technology transfer

Normative principles

The Universal Declaration of Human Rights (UDHR) is the normative basis from which discussions on the right to development emerged. According to Article 22 of the UDHR, "Everyone, as a member of society, has the right to social security and is entitled to realization…of the economic, social and cultural rights indispensable for his dignity and the free development of his personality." By 1986, the UN General Assembly had adopted the Declaration on the Right to Development, according to which "every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realized."[21]

This broader view of human development is given a basic needs approach in Article 25 which states that "[e]veryone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services." The UN has played a key role in elaborating these elements through treaties as well as executive agencies.

These basic needs can hardly be met without significant and sustained investment in education as well as science and technology. In this regard, the UDHR, in Article 26, states that, "Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit."

21 General Assembly Resolution 41/128. Declaration on the Right to Development, 4 December 1986. On the background to and current analysis of this declaration, see Office of the High Commissioner for Human Rights, *Realizing the Right to Development: Essays in Commemoration of 25 Years of the United Nations Declaration on the Right to Development*, Geneva: OHCHR, 2013.

More directly relevant to the normative foundation of the relations between human rights and technology transfer is Article 27 of the UDHR, which states, "Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits."[22] The ICESCR, a binding treaty on states that have ratified it, stipulates in Article 15 that States Parties "recognize the right of everyone" both "to enjoy the benefits of scientific progress and its applications" and "to benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author."

In the 1975 Declaration on the Use of Scientific and Technological Progress in the Interest of Peace and for the Benefit of Mankind, the General Assembly called for "measures to extend the benefits of science and technology to all strata of the population…" More recently, the Universal Declaration on the Human Genome and Human Rights, adopted by UNESCO in 1997, called on states "to encourage measures enabling … developing countries to benefit from the achievements of scientific and technological research so that their use in favour of economic and social progress can be to the benefit of all." The 2005 Universal Declaration on Bioethics and Human Rights, also adopted by UNESCO, in its Article 15 on sharing benefits, affirms that "Benefits resulting from any scientific research and its applications should be shared with society as a whole and within the international community, in particular with developing countries" and enumerates seven forms of cooperation to give effect to this principle.[23]

These normative principles laid the basis for the appreciation of investing in human resource development as a foundation for improved human welfare. Most of these norms focused on national activities even though the basis

22 An elaboration of this theme was reflected in the Declaration on the Use of Scientific and Technology Progress in the Interests of Peace and for the Benefit of Mankind, adopted by United Nations General Assembly in 1975, which includes the following: "All States shall promote international co-operation to ensure that the results of scientific and technological developments are used in the interests of strengthening international peace and security, freedom and independence, and also for the purpose of the economic and social development of peoples and the realization of human rights and freedoms in accordance with the Charter of the United Nations."

23 The seven measures are "(a) special and sustainable assistance to, and acknowledgement of, the persons and groups that have taken part in the research; (b) access to quality health care; (c) provision of new diagnostic and therapeutic modalities or products stemming from research; (d) support for health services; (e) access to scientific and technological knowledge; and (f) capacity-building facilities for research purposes; (g) other forms of benefit consistent with the principles set out in this Declaration."

for international cooperation was laid out in the UDHR. Education as such could only be provided domestically with minimum demand for international financial transfers from the industrialized nations. But technology, which was defined mainly as the application of science to solving human needs, was seen as a bundle of physical and tacit assets whose transfer required larger financial investments as well as changes in rules governing access to proprietary knowledge transfer. In the early days of the debate little was known about the origins, structure, and evolution of technology.[24] These seeming differences, however, were interlinked because technology acquisition was largely dependent on the existence of initial technical competence, especially in fields such as engineering. The introduction of new technology also spurs demand for local education in related fields.

To view human rights and capabilities as dynamic and unfolding, one would need to look beyond classical jurisprudence that assumes that the world rests in some form of equilibrium from which it is often jolted, requiring corrective measures. Similarly, the view that rights are self-activating and pre-ordained undercuts the significant role that states can play in expanding human possibilities. Indeed, the principles set out in the UDHR are constantly being elaborated through additional UN normative instruments. For this reason, a more dynamic approach that builds on evolutionary principles is a more helpful intellectual vantage point.[25]

Technology transfer or acquisition?

It is instructive that the UDHR also recognizes the critical role creativity plays in human development. Article 27, quoted above, refers to participation in cultural life and enjoyment of the arts, as well as sharing in scientific advancement and its benefits. These rights are also related to Article 19 of the UDHR and of the International Covenant on Civil and Political Rights (ICCPR) on freedom of opinion and expression, including freedom to hold opinions without interference and to seek, receive, and impart information and ideas through any media regardless of frontiers. One extension of this

24 W. Brian Arthur, *The Nature of Technology: What It Is and How It Evolves* (New York: Free Press, 2009).

25 Norman Clark and Calestous Juma, *Long-Run Economics: An Evolutionary Approach to Economic Growth* (London: Frances Pinter, 1987).

right was the Declaration of Principles of the United Nations-convened World Summit on the Information Society (WSIS), reaffirming the right, "as an essential foundation of the Information Society." Without declaring Internet access a human right, the WSIS reaffirmed that "Everyone, everywhere should have the opportunity to participate and no one should be excluded from the benefits the Information Society offers."[26]

In his 2011 report on the relationship between the right to freedom of information and Internet access, the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression came much closer to proclaiming access to the Internet as a human right. "Although access to the Internet is not yet a human right as such," he noted, "States have a positive obligation to promote or to facilitate the enjoyment of the right to freedom of expression and the means necessary to exercise this right, which includes the Internet."[27]

Significantly for the issue of technology transfer and technology acquisition, he recalled that access to the Internet is essential to enjoy "other rights, such as the right to education, the right to freedom of association and assembly, the right to full participation in social, cultural and political life and the right to social and economic development."[28] Enabling individuals effectively to use the content made available via the Internet requires a number of elements, including the skills to use the technology. The Special Rapporteur thus recommends that States include Internet literacy skills in school curricula and training outside of schools.[29]

These general recommendations have been implemented in various national settings. In 2009, for example, Finland declared access to one megabit of broadband connection a legal right in the country,[30] and the French Constitutional Court ruled that Internet access is protected by the rights to

26 *Declaration of Principles: Building the Information Society: a global challenge in the new Millennium*, UN Doc. WSIS-03/GENEVA/DOC/4-E, 12 December 2003, para. 4. See also Cees J. Hamelink, "Human Rights Implications of WSIS, *Revue québécoise de droit international*18, 1 (2005): 27-39.

27 *Report of the Special Rapporteur on the promotion and protection of the right to freedom of opinion and expression*, UN Doc. A/66/290, 10 August 2011, para. 61.

28 Ibid.

29 Ibid., para. 84.

30 Don Resinger, "Finland makes 1Mb broadband access a legal right," CNET, October 14, 2009, accessed at http://www.cnet.com/news/finland-makes-1mb-broadband-access-a-legal-right/

information and communications.[31] Such measures reflect the growing recognition of the role of technology in strengthening human capabilities.[32]

The rights enshrined in the UDHR are not directly linked to development rights although they provide the normative basis upon which the international community, as reflected in Article 28, has sought to articulate development as a human right.[33] Traditional rights advocates have sought to use these articles as a basis to demand access to technologies and opportunities developed in the industrialized countries. The traditional concept of "technology transfer" derived its political authority from an entitlement-based interpretation of the UDHR, i.e., the right to share in scientific advancement and its benefits.

The rights-based approach inspired a naive view starting in the early 1960s that developing countries could "leap across generations" and industrialize through the transfer of technology from industrialized countries. This view became the basis for a large number of UN conferences and treaties covering fields such as education, health, food and agriculture, industry, environment, and climate change. These initiatives were part of the "birth of development" following World War II efforts "when discrete groups of people with international stature, expertise, power, influence, and the best of intentions began to work to better the lives of other human beings whom they had never met or known, for no reason other than the desire to improve the fate of the human race."[34]

Clauses of "access to, and transfer of technology" became major issues of contention between developed and developing countries in various international fora. Much of the debate occurred around issues such as intellectual

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31 Patrick Roger and Jean-Baptiste Chastand, "Hadopi: le Conseil constitutionnel censure la riposte graduée," *Le Monde*. 10 June 2009, accessed at http://www.lemonde.fr/technologies/article/2009/06/10/hadopi-le-conseil-constitutionnel-censure-la-riposte-graduee_1205290_651865.html. See also Cees Hamelink, *Human Rights in Cyberspace*, accessed at http://www.religion-online.org/showarticle.asp?title=283 (viewed 29 August 2013).

32 William Birdsall, "Human Capabilities and Information and Communication Technology: The Communicative Connection," *Ethics and Information Technology* 13, no. 2 (2011): 93–106.

33 Philip Alston and Mary Robinson, eds., *Human Rights and Development: Towards Mutual Reinforcement* (Oxford: Oxford University Press, 2005). See also Bård Anders Andreassen and Stephen P. Marks (eds.), *Development as a Human Right: Legal, Political and Economic Dimensions*, 2nd revised edition (Antwerp, Neth/Oxford, UK/Portland, OR: Intersentia, 2010).

34 Amy L. S. Staples, *The Birth of Development: How the World Bank Food And Agriculture Organization, And World Health Organization Have Changed the World 1945-1965* (Kent, OH: Kent State University Press, 2006).

property rights, which were perceived by developing countries as going against their right to improved health and agriculture.[35] There is ample evidence to show that low investments in human capabilities are a much larger obstacle in fields such as agriculture than the narrow barriers posed by intellectual property restrictions.[36]

There are growing calls for intellectual property rules to be "redesigned so that the development of any new drug is rewarded in proportion to its impact on the global disease burden (not through monopoly rents)."[37] These debates will continue on normative grounds despite the absence of conclusive evidence over the impact of stronger intellectual property protection on global health.[38]

Similar uncertainties remain in the field of climate change. Renewable energy technologies have the potential of addressing some of the challenges associated with greenhouse gas emissions. Industrialized countries and emerging nations such as China are making significant investments in such technologies. However, the extent to which intellectual property rights are likely to facilitate or hinder their transfer to developing countries remains a subject of conjecture and uncertainty.[39]

Two landmark debates illustrate this point. The first was the UN Conference on Science and Technology for Development held in Vienna in 1979, which focused on technology transfer. The conference created a center, a fund, and a commission. After extensive diplomatic confrontations between industrialized and developing countries, the center was abolished in 1993. The fund and commission were subsumed in other UN agencies. The conflicts over

35 National Research Council, *Knowledge and Diplomacy*: *Science Advice in the United Nations System* (Washington, DC: National Academy of Sciences 2002).

36 Calestous Juma, *The New Harvest: Agricultural Innovation in Africa* (New York, Oxford University Press, 2015).

37 Thomas Pogge, "Human Rights and Global Health: A Research Program," *Metaphilosophy* 36, no. 1/2 (2005): 182.; A. Buchanan, T. Cole, and R.O. Keohane, "Justice in the Diffusion of Innovation," *The Journal of Political Philosophy*, DOI online publication (2009): pp. 1-27.

38 Anna Dahlberg, "Are Stronger Intellectual Property Rights an Obstacle or a Condition for International Technology Transfer: An Analysis of the Impact of the TRIPS Agreement" (Faculty of Law, University of Lund, 2004).

39 Keith E. Maskus and Ruth L. Okediji , *Intellectual Property Rights and International Technology Transfer to Address Climate Change: Risks, Opportunities and Policy Options* (Geneva: International Centre for Trade and Sustainable Development, 2010); Keith Maskus, *Differentiated Intellectual Property Regimes for Environmental and Climate Technologies* (No. 17. OECD Publishing, 2010).

technology transfer in effect led to one of the few occasions when the United Nations abolished one of its centers.

Over the same period, the UN Conference on Trade and Development (UNCTAD) sought to develop a "code of conduct" for technology transfer that would enable developing countries to have access to technologies developed in the industrialized countries.[40] The draft "code of conduct" was a precursor to a wide range of confrontations over intellectual property rights in almost all the major multilateral negotiations.[41]

The late 1970s was a period of ferment in the UN system in regard to relationships between technology and human rights. The adoption of new international environmental norms with explicit scientific and technological provisions started to come to the fore over that period. The connections between environmental degradation, human rights, and the importance of access to remedial technologies quickly became a key theme in negotiations over sustainable development as reflected in the outcomes of the 1992 UN Conference on Environment and Development held in Rio de Janeiro, Brazil.[42]

The call for technology transfer to address climate change as a human rights issue has continued to intensify.[43] A human rights approach is used to expand the scope of support to include "a range of interests and obligations beyond the transfer of a clean energy technology to a developing country. Funding and programmatic support for the development stage of clean energy technology in developing states is a more sustainable fix for the climate change problem."[44]

Many of the demands made by developing countries ignored the fact that technology is usually acquired, not necessarily transferred as a right.

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40 Surendra Patel, Pedro Roffe, and Abdulqawi Yusuf, eds., *International Technology Transfer : The Origins and Aftermath of the United Nations Negotiations on a Draft Code of Conduct* (The Hague: Kluwer Law International, 2001).

41 Keith Maskus and Jerome Reichman (eds.), *International Public Goods and Technology Transfer under a Globalized Intellectual Property Regime* (Cambridge, UK: Cambridge University Press, 2005).

42 Calestous Juma and J. B. Ojwang, *Technology Transfer and Sustainable Development: International Policy Issues* (Nairobi: ACTS Press, 1992).

43 Stephen Humphreys, "Perspective: Technology Transfer and Human Rights: Joining Up the Dots," *Sustainable Development Law & Policy* 9, no. 3 (2009): 2–3.

44 Kavita Kapur, "Climate Change, Intellectual Property, and the Scope of Human Rights Obligations," *Sustainable Development Law & Policy* 11, no. 2 (2011): 95–97.

Technology transfers are limited by factors such as the lack of absorptive capacity in the importing countries. Other factors such as the lack of spare parts supply, differences in ecological conditions, and absence of supportive legal environments make it difficult for transplanted technologies to take root.[45]

Even where such transfers are made, there is usually need for research to adapt the technology to local conditions. In effect, the appropriate metaphor is technology domestication, which shifts a great deal of responsibility from the technology supplier to the importer. This shift is not rhetorical but a fundamental reformulation of the nature of technology development from transfer to acquisition. It represents an active articulation of capabilities as opposed to an appeal to natural rights.[46]

45 Calestous Juma and Yee-Cheong Lee, *Innovation: Applying Knowledge in Development* (London: Earthscan, 2005).

46 Sazali Abdul Wahab, Raduan Che Rose, and Suzana Idayu Wati Osman, "Defining the Concepts of Technology and Technology Transfer: A Literature Analysis," *International Business Research* 5, no. 1 (2012): 61–71.

3. Technological capabilities and innovation systems

Technological capabilities

While most developing countries pressed for technology transfer through multilateral forums, a new development paradigm based on technology acquisition and absorption was unfolding in a select number of Southeast Asian countries—led by South Korea, which was emulating Japan.[47] The concept of absorptive capacity is central to technological development as it entails an "organization's relative ability to develop a set of organizational routines and strategic processes through which it acquires, assimilates, transforms and exploits knowledge acquired from outside the organization in order to create value."[48]

South Korea's industrial ascendancy shattered many of the preconceived views of the time. In the early 1960s the country's level of development was comparable to many African countries. But it framed its pursuit for development through a different model of development, which emphasized strengthening the absorptive capacity of the population.[49] It was a variant on the theme of development rights that reflected the critical role of learning as a driver of economic transformation. Korea undertook to create development rights rather than assume that rights were inalienable. In other words, rapid economic growth and technological innovation of the "developmental state" in South Korea were accompanied by state provisions of improved education, health, and standard of living while severely curtailing worker rights and especially civil and political rights.[50] More recently, in Korea's model both human rights and capabilities are social and political creatures whose emergence owed much to the active role of the state.

47 Linsu Kim, *Imitation to Innovation: The Dynamics of Korea's Technological Learning* (Boston: Harvard Business Review Press, 1997).

48 Maria Jiménez-Barrionuevo, Victor García-Morales, and Luis Molina, "Validation of an Instrument to Measure Absorptive Capacity," *Technovation* 31, no. 5–6 (2011): 190–202.

49 Nika Murovec and Igor Prodan, "Absorptive Capacity, Its Determinants, and Influence on Innovation Output: Cross-Cultural Validation of the Structural Model," *Technovation* 29, no. 12 (2009), 859–72.

50 William Shaw (ed.), *Human Rights in Korea: Historical and Policy Perspectives*, (Cambridge, MA: Harvard Studies in East Asian Law, Harvard University Press, 1991).

Technological innovation is therefore not simply a matter of acquiring and installing machinery, but it entails a transformation of society and its value systems.

This transformational nature of innovation became the dominant driver of socio-economic evolution. "The main characteristics of innovation—uncertainty, search, exploration, financial risk, experiment, and discovery—have so permeated the West's expansion of trade and the West's development of natural resources as to make it virtually an additional factor of production."[51]

This view of capabilities as a dynamic process of expanding possibilities also included forging new trade relations between the newly-industrialized countries and western countries. South Korea, Taiwan, and Singapore relied heavily on external competitive markets in which they could only compete through entrepreneurship, innovation, and management.[52] Their view of an enabling international environment focused more on bilateral arrangements and less on multilateral appeals through the UN and other international agencies and even less on ensuring respect for human rights during the most intensive periods of growth.

As the founding father of modern Singapore put it, the "quality of a nation's manpower is the single most important factor determining national competitiveness. It is the people's innovativeness, entrepreneurship, team work, and their work ethic that give them a sharp keen edge in competitiveness."[53] This outlook translated into policy focus on improving the educational system and ensuring that it had the ability to adapt to changes in the global competitiveness environment.

It is therefore not a surprise that Singapore's educational system continues to be ranked one of the best in the world. Moreover, Singapore also uses its educational system to tackle income inequality.[54] To a large extent this is because

51 Nathan Rosenberg and L. E. Birdzell, *How the West Grew Rich: The Economic Transformation of the Industrial World* (New York: Basic Books, 1985).

52 S. Lall and S. Urata (eds.), *Competitiveness, FDI and Technology Activity in East Asia,* (Cheltenham, UK: Edward Elgar, 2003).

53 Graham Allison, et al., *Lee Kuan Yew: The Grand Master's Insights on China, the United States, and the World* (Cambridge, MA: MIT Press, 2013).

54 Pundarik Mukhopadhaya, "Education Policies as Means to Tackle Income Disparity: The Singapore Case', *International Journal of Social Economics* 29, nos 11/12(2002): 946-955.

the educational system is part of a larger network of institutional arrangements designed to foster global competitiveness. In this regard, education aimed at building capabilities of agents of development, or a "system of innovation," is more narrowly conceived than the right to education as set out in Article 26 of the UDHR, which is to "be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms." As has been noted, the Singaporean approach "differs significantly from the principles, rights, and institutions sponsored by the UDHR and the West, and is a product of the unique historical circumstances of the country and an ideology committed first and foremost to economic development."[55]

Innovation systems

Nation states have historically provided the context within which innovation systems emerged. It is also for this reason that early work on innovation took on primarily a national character. Niosi, Saviotti, Bellon, and Crow define innovation system as "interacting private and public firms... universities and government agencies, aiming at the production of science and technology within national borders."[56]

Even though innovation policies are largely national, they operate in open global arenas where actors are forced to find ways of balancing trade-offs and complementarities. The "challenge for policy is to support the domestic embedding of internationally linked industries, which through these linkages develop specialized knowledge which spills over into their surroundings and is recombined and transformed by the larger innovation system."[57]

Tapping into global systems to meet national needs presupposes the existence of requisite capabilities in domestic institutions and enterprises. Such

55 Melanie Chew, "Human Rights in Singapore: Perceptions and Problems," *Asian Survey* 34, no. 11 (Nov, 1994): 948.

56 Jorge Niosi et al., "National Systems of Innovation: In Search of Workable Concept," *Technology in Society* 15, no. 2 (1993): 207–27; Metcalfe, S. and Ramlogan, R. 2008. "Innovation Systems and the Competitive Process in Developing Economies," *Quarterly Review of Economics and Finance* 48, no. 2(208): 433-446.

57 Sverre J. Herstad et al., "National Innovation Policy and Global Open Innovation: Exploring Balances, Tradeoffs and Complementarities," *Science and Public Policy* 37, no. 2 (2010): 113–24.

capabilities vary considerably across countries and fall in at least four categories: technological, governance, political, and openness.[58] It is therefore not just the existence of technological opportunities in the industrialized countries that matters, but also more critically the presence of social capabilities in the recipient nations that defines the possibilities for technological catch-up.[59] The catching process does not occur automatically just because technologies are transferred through foreign direct investment or joint venture. The process involves going beyond production and execution. It involves deliberate local measures aimed at building up capacity for innovation.[60]

It is through interactions in global systems that many of the clashes between technological innovation and human rights start to unfold. Take the case of intellectual property protection. Developing countries consider access to key pharmaceutical technologies to be essential for their ability to fulfill their obligations to provide their citizens with adequate health care. But international technology transactions are governed by intellectual property rights.[61]

In recent years trade-related intellectual property agreements have become increasingly stronger so as to curtail piracy and counterfeiting. "Thus far, the high standards for intellectual property protection and enforcement incorporated into these agreements have raised significant tension between intellectual property and human rights systems."[62] We need a working balance between the two systems, especially in light of the growing "acrimonious and unresolved clashes over substantive rules and values, competition among international institutions for policy dominance, and a proliferation of fragmented and incoherent treaty obligations and nonbinding norms."[63]

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58 Jan Fagerberg and Martin Srholec, "National Innovation Systems: Capabilities and Economic Development," *Research Policy* 37, no. 9 (2008): 1417–35.

59 Moses Abramovitz, "Catching Up, Forging Ahead, and Falling Behind," *Journal of Economic History* 46, no. 2 (1986): 385–406; Roberto Mazzoleni, "Catching Up and Academic Institutions: A Comparative Study of Past National Experiences," *Journal of Development Studies* 44, no. 5 (2008): 678–700.

60 Kyung-Min Nam "Learning through the International Joint Venture: Lessons from the Experience of China's Automotive Sector," *Industrial and Corporate Change* 20, no. 3 (2011): 855-907.

61 Andrew D. Mitchell and Tania Voon, "Patents and Public Health in the WTO, FTAs and Beyond: Tension and Conflict in International Law," *Journal of World Trade* 43, no. 3 (2009): 571–601.

62 Peter Yu, "Intellectual Property and Human Rights in the Nonmultilateral Era," *Florida Law Review* 64 (2012): 1045–1100.

63 Lawrence Helfer, "Toward a Human Rights Framework for Intellectual Property," *UC Davis Law Review* 40 (2007): 971–1020.

The Agreement on Trade-Related Investment Measures (TRIMs) under the World Trade Organization (WTO) is another source of tension between innovation and human rights. The aims of the Agreement include expanding and progressively liberalizing world trade and facilitating investment across countries to increase economic growth while ensuring free competition. Specifically, it seeks to prevent the adoption and utilization of legislative and other investment-related measures that may cause trade restrictive and distortive effects.

Annexed to the agreement is an illustrative list of prohibited trade-related investment measures, which include: (1) local content measures which require firms to source a specified amount of input locally; (2) trade-balancing rules which limit buying or use of imported products by firms to amounts related to the volume or value of local products they export; (3) foreign-exchange balancing measures which limit imports by curtailing access to foreign exchange; and (4) restrictions on firm exports either by volume or value.[64] Many governments are concerned that these restrictions could potentially affect their industrial and technological development goals.

In the short run, it appears that both the WTO Agreement on Trade-Related Intellectual Property Rights (TRIPs) and TRIMs could have detrimental impacts on the ability of developing countries to meet their human rights obligations. The most telling example has been the impact of TRIPs on access to medicines. In 2001, the Commission on Human Rights recognized "that access to medication in the context of pandemics such as HIV/AIDS is one fundamental element for achieving progressively the full realization of the right … to … health"[65] and the WTO adopted the same year the Doha Declaration on the TRIPS Agreement and Public Health, in which it declared: "The TRIPS agreement does not and should not prevent members from taking measures to protect public health … in particular to promote access to medicines for all" and reaffirmed "the right of WTO members to use, to

64 Ibid., Annex, article 2.

65 Commission on Human Rights resolution 2001/33, Access to medication in the context of pandemics such as HIV/AIDS, UN Doc. E/CN.4/RES/2001/33, 20 April 2001, para. 3(a).

the full, the provisions in the TRIPS Agreement, which provide flexibility for this purpose."[66]

The Committee on Economic Social and Cultural Rights issued a "Statement on Human Rights and Intellectual Property" in which it considered that "intellectual property rights must be balanced with the right … to enjoy the benefits of scientific progress and its applications."[67] "States Parties should," according to the Committee, "… ensure that their intellectual property regimes constitute no impediment of their ability to comply with their core obligations in relation to the right to health … States thus have a duty to prevent that unreasonably high license fees or royalties for access to essential medicines … undermine the right … of large segments of the population to health …"[68]

Indeed, there is a need to find a working balance between the two systems. However, the two WTO agreements illustrate the urgency for developing countries to invest more effort in building local capabilities as a foundation for meeting their human rights obligations related to improving human well-being. The Intergovernmental Working Group on Public Health, Innovation and Intellectual Property (IGWG), and the Global Strategy and Plan of Action, adopted by the World Health Assembly, have sought to fill that gap.[69]

66 World Trade Organization, Ministerial Conference, Fourth Session, Doha, 9–14 November 2001, Declaration on the TRIPS agreement and public health, adopted on 14 November 2001, Doc. WT/MIN(01)/DEC/2, 20 November 2001, paras. 4-5, available at http://www.wto.org/English/thewto_e/minist_e/min01_e/mindecl_trips_e.htm.

67 Human Rights and Intellectual Property: Statement by the Committee on Economic Social and Cultural Rights, UN Doc. E/C.12/2001/15, 14 December 2001, para. 4.

68 Committee on Economic, Social and Cultural Rights, General Comment No. 17 on the right of everyone to benefit from the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he or she is the author, UN doc. E/C.12/GC/17, 12 January, 2006, para. 35.

69 WHO Resolution 61.21 adopted by the Sixty-first World Health Assembly on 24 May 2008.

Financing innovation

One of the challenges facing emerging countries in their aspirations for structural transformation is how to finance technological innovation in general and industrial development in particular. The general tendency in international negotiations has been to extend the logic of "technology transfer" to financing for development. This is often presented as an analogy to the Marshall Plan that supported the reconstruction of Western Europe after World War II. These calls often ignore differences between the skill levels in post-war Europe and many of today's emerging nations that are still in the early stages of building their economies. Many of the major international development agreements include the need to transfer financial resources from the industrialized nations to emerging nations. This appeal undercuts the ability of emerging nations to explore how they can leverage their domestic financial assets to finance innovation. There are many mechanisms that have been leveraged by numerous emerging national plans to finance innovation. A large part of the current discussion on the issue tends to focus largely around the role of venture capital and other instruments that have evolved recently in more advanced nations.[70]

The point here is not simply about mobilizing investment capital and finding ways to align the incentives of local banking institutions with the need to build domestic technological capabilities and the expansion of the human potential. The general view is that local banks are too risk-averse to finance industrial projects, except in proven technologies for less uncertain markets. Banks are viewed largely as mechanisms for allocating capital, screening firms, and monitoring corporate activities.[71] The lending activities of most banks are limited within national boundaries. They often operate under strict national laws that reduce their ability to expand operations into new areas, especially those that involve new technologies. The solution to this problem

70 Guy Ben-Ari and Nicholas Vonortas, "Risk Financing for Knowledge-based Enterprises: Mechanisms and Policy Options," *Science & Public Policy* 34, no. 7 (2007): 475-488; Øyvind Bjørgum and Roger Sørheim, "The Funding of New Technology Firms in a Pre-commercial Industry – The Role of Smart Capital," *Technology Analysis & Strategic Management* 27, no. 3 (2015): 249-266; Yong Li and Shaker Zahra, "Formal Institutions, Culture, and Venture Capital Activity: A Cross-country Analysis," *Journal of Business Venturing* 27, No. 1 (2012): 95-111.

71 Sudipto Bhattacharya, Arnoud Boot and Anjan Thakor, "The Economics of Bank Regulation," *Journal of Money, Credit and Banking* 30, no. 4 (1998): 745-770; Franklin Allen, "The Market for Information and the Origin of Financial Intermediation," *Journal of Financial Intermediation* 1, no. 1 (1990): 3–30.

may lie in the catalytic role of regional integration efforts that signal the emergence of large markets.

Historically, banks acted as catalysts for industrialization in Western Europe and the United States. Evidence from the early role of banks in select countries such as Belgium (1830-1850), Germany (1850-1870), and Italy (1894-1914) shows that banks "will only play a catalytic role if they are sufficiently large to invest in a critical mass of firms. And they need to have enough market power to recoup the cost of mobilizing the critical mass."[72] The cost of mobilizing the critical mass of firms was reduced in cases where banks owned equity. "The intuition is that equity allows banks to participate in the value they create by mobilizing the critical mass. This leads to the additional prediction…that universal banks will find it easier to promote investments in new industries."[73]

In the Unites States, the "passage of the National Banking Acts [of 1863 and 1864] stabilized the existing financial system and encouraged the entry of 729 banks between 1863 and 1866. These new banks concentrated in the area that would eventually become the Manufacturing Belt."[74] Evidence "shows that these changes to the financial system were a major determinant of the geographic distribution of manufacturing and the nation's sudden capital deepening. The entry not only resulted in more manufacturing capital and output at the county level, but also more steam engines and value added at the establishment level."[75]

Despite the differences with emerging nations, many of the challenges of expanding industrial output and promoting structural transformation are similar to those that prevailed in the early history of Europe and the United States. The signal of larger and growing markets provided incentives for the expansion and consolidation of banking services, which increased the capital available for industrial investment. It was not the expansion industries that resulted in capital accumulation. It was the expansion of financial services

72 Marco Da Rin and Thomas Hellmann, "Banks as Catalysts for Industrialization," *Journal of financial Intermediation* 11, no. 4 (2002): 368.

73 Ibid.

74 Matthew Jaremski, "National Banking's Role in US Industrialization, 1850-1900," *Journal of Economic History* 74, no. 1 (2017): 109.

75 Ibid.

that resulted in industrial growth. This early role of banks as catalysts for industrial development in emerging markets deserves special attention when exploring ways to transform the structure of African economies.

Probably one of the most important examples of regional integration is the emergence of pan-African banks (PABs), which are becoming more important than the long-established foreign banks mostly from Europe and the United States. "There has been a rapid expansion of pan-African banks (PABs) in recent years, with seven major PABs having a presence in at least ten African countries: three of these are headquartered in Morocco, two in Togo, and one each in Nigeria and South Africa."[76] Other banks, mainly from Kenya, Nigeria, and South Africa, "have a regional presence with operations in at least five countries. PABs have a systemic presence in around 36 countries."[77]

Some of the leading PABs originate from Kenya (Equity Bank and Commercial Bank of Kenya), Morocco (Attijariwafa Bank, Banque Marocaine du Commerce Extérieur, Bank of Africa, and Groupe Banque Centrale Populaire), Nigeria (Guaranty Trust Bank and United Bank for Africa), South Africa (Nedbank and Standard Bank), and Togo (Ecobank/ETI and Oragroup). The footprints of the PABs roughly map onto the geographical space of Africa's Regional Economic Communities (RECs) in East, South, West, and North Africa.

Of the banks, those from Morocco have shown the strongest interest in financing industrial development. "As part of their expansion strategy, Moroccan banks export their business model characterized among others on development of small and medium-sized enterprises [SMEs] as well as the high supervision standards imposed by the Moroccan central bank—Bank Al-Maghrib (BAM)."[78] Morocco can act as a strategic bridge between Europe and Africa in promoting technology-based businesses. The early focus on

76 Charles Enoch, Paul Henri Mathieu, Mauro Mecagni, Jorge I Canales Kriljenko. *Pan-African Banks: Opportunities and Challenges for Cross-Border Oversight* (Washington, DC: International Monetary Fund, 2015): 1.

77 Ibid.

78 Charles Enoch, Paul Henri Mathieu, Mauro Mecagni, Jorge I Canales Kriljenko. *Pan-African Banks: Opportunities and Challenges for Cross-Border Oversight* (Washington, DC: International Monetary Fund, 2015): 79.

SMEs could be seen as a starting point in demonstrating the importance of lending for industrial development.

It is expected that the adoption of agreements expanding the African free trade area and their implementation will help to facilitate the consolidation and expansion of PABs. But more importantly, the need to produce goods and services that can be traded among African countries will also provide incentives for PABs to increase their lending to industrial development.

Banks are not the only sources of support for innovation and industrial development. Many countries have pursued alternative approaches such as state funding and the creation of conglomerates. These measures should be part of the growing financial ecology that supports Africa's structural transformation. These ideas are not new. Applying them today is not returning to the past either. The design of banks to catalyse industrial development occurred when Western countries were emerging economies. This is the stage at which Africa is today and some of these experiences provide heuristics—not transferrable models—that Africa can learn from.

4. Human rights in the age of exponential innovation

Focusing on barriers to access to knowledge and technology now needs to be complemented by a shift in focus to building up the requisite capabilities in developing countries to harness existing knowledge for human development.[79] New research is needed to understand the extent to which human rights interact with at least three critical areas of relevance in the age of technological abundance: infrastructure; technical education; and entrepreneurship. These are not just challenges for the developing world but appear to be of great policy interest worldwide.

Infrastructure, technology, and human capabilities

No society can function effectively without adequate infrastructure. It is a platform upon which all other human activities are based. Infrastructure can be defined as the facilities, structures, and associated equipment and services that facilitate the flows of goods and services between individuals, firms, and governments.[80] Conventional infrastructure includes: public utilities such as power, telecommunications, water supply, sanitation and sewerage, and waste disposal; public works such as irrigation systems, schools, housing, and hospitals; transport sectors such as roads, railways, ports, waterways, and airports; and research facilities such as laboratories and their related equipment. Building engineering capabilities is critical to infrastructure development.

Infrastructure services include the provision, operation, and maintenance of the physical facilities. Poor infrastructure is a critical barrier to improvement in human well-being because it serves as the motherboard upon which all economic secondary activities are processed.[81] But little is written about

79 Gabriela. Dutrénit, "The Transition from Building up Innovative Technological Capabilities to Leadership by Latecomer Firms," *Asian Journal of Technology Innovation* 15, no. 2 (2007): 125–49.

80 Calestous Juma, *Redesigning African Economies: The Role of Engineering in International Development* (London: Royal Academy of Engineering, 2006).

81 Anupam Ghosh, "Physical Infrastructure and Development of Secondary Sector: An Econometric Analysis for Six States in India," *The Journal of Developing Areas* 44, no. 2 (2011): 207–16.

the implications of poor infrastructure for democracy. It is evident upon reflection that regions of the world without adequate infrastructure will have difficulties exercising certain democratic rights such as voting. It is one thing to have freedom of expression; it is another to have the capacity for expression. Having that capacity may be dependent on infrastructure services such as transportation, energy, and communications.

The impact of poor infrastructure extends to the ability to produce food or improve health.[82] Infrastructure undergirds all other subsequent technological developments. In a way, it is the foundation upon which all other capabilities can be expressed but its design and maintenance also require the support of the same technological capabilities.

The advancement of information technology and its rapid diffusion in recent years required basic telecommunications infrastructure such as telephone, cable, and satellite networks. In addition, electronic information systems, which rely on telecommunications infrastructure, account for a substantial share of production and distribution activities in the secondary and tertiary sectors of the economy.

It can be argued therefore that adequate infrastructure is essential not only as a basis for economic development but also as a foundation of realizing human rights and expanding liberties. It is critical in giving effect to human capabilities and should therefore be a subject of further research on both technological innovation and human rights. So far much of the discussion over infrastructure has tended to focus on narrow economic arguments about rates of return to investment or institutional arrangements such as private-public-partnerships. The case for extending the discussion into the domain of human rights is evident when we examine the role it plays in the improvement of the human condition.

Expanding infrastructure investment in some sectors also expands opportunities to realize the human potential through the benefits of scaling. Markets in most emerging regions tend to be small and fragmented and do not allow producers or consumers to benefit from economies of scale and learning

82 Calestous Juma, *The New Harvest: Agricultural Innovation in Africa* (New York: Oxford University Press, 2015); M. Fay et al., "Achieving Child-Health-Related Millennium Development Goals: The Role of Infrastructure," *World Development* 33, no. 8 (2005): 1267–84.

effects. The more important benefits of large markets lie in the geometrical scaling arising from engineering principles. Such scale effects are integral to the geometry and the physical nature of the world.[83] In fact, the benefits of geometrical scaling are often mistaken with economies of scale. It is because of the inherent benefits of geometrical scaling that chemical and processing plants show larger benefits of economies of scale than say assembly plants.

Increased manufacturing as a result of larger markets extended the benefits of geometrical scaling to the transportation sector. "Transportation equipment—such as oil tankers, freighters, industrial trucks, buses, trains, and to some extent aircraft—all benefit from increases in scale. In addition to the benefits from increasing scale in engines, the reason is that the cost of the transportation equipment is largely a function of their outer surface area (e.g., dimension squared) while the output is a function of volume (dimension cubed)."[84] What may appear as modest increases in the size of transportation equipment yields significant benefits due to the inherent natural properties of geometrical scaling.

African countries have already reaped great benefits from geometrical scaling that involves the use of integrated circuits (ICs) in devices such as mobile phones, digital cameras, and computers. Reducing the scale of transistors and storage regions, for example, has resulted in many orders of magnitude of improvements in performance and reduction in price. The scaling led to the emergence of "personal and portable computers, mobile phones, and the Internet industries, as well as new industries within broadcasting, telecommunication, health care (including biotechnology), education, and financial sector."[85] The increasing integration of electronics in a wide range of process technologies helps to maximize the benefits of scaling either through scaling up or reducing the scale.

The implications of geometrical scaling are profound for Africa's regional integration efforts. They underscore the importance of focusing on industrialization as a way to realize the benefits of larger markets. The capital costs

83 Lipsey, R.et al. (eds). 2005. *Economic Transformations: General Purpose Technologies and Long-Term Econonic Growth* Oxford University Press, New York.

84 Jeffrey Lee Funk, "What Drives Exponential Improvements?" *California Management Review* 55, no 3 (2013): 138-139.

85 Jeffrey Lee Funk, *Technology Change and the Rise of New Industries* (Stanford, CA, Stanford University Press, 2013): 51.

of investment in chemical processes rise much slower than output as the physical plants are scaled. In assembly plants, however, physical scaling is rarely increased, and the common practice is to replace human labor with machines. This engineering insight also provides additional justification for investing in engineering capabilities and entering into manufacturing. It also gives indications of the kinds of industries that are likely to have significant welfare effects from regional integration. Much of the industrial learning associated with geometrical scaling occurs outside production settings. This general purpose knowledge is transferrable to other industries more readily than the learning gained in production. Knowledge of geometric scaling gained in brewing, for example, can be extended to other sectors such as pharmaceutical production.

Technical education and the expansion of human capabilities

Much of the debate over access to education as a human right has tended to focus on primary and secondary education. Nevertheless, as noted by the Special Rapporteur on the right to education, "International human rights instruments clearly establish technical and vocational education and training as part of both the right to education and the right to work."[86] However, addressing the global grand challenges outlined above will require significant investment in human capabilities, especially in the technical fields. Higher technical education is increasingly recognized as a critical aspect of the development process, especially with the growing awareness of the role of science, technology, and innovation in economic renewal.

While primary and secondary education have been at the focus of donor community attention for decades, higher education and research have been viewed as essential to development only in recent years. The challenges include building human capacity and transmitting technical skills to succeeding generations, which underscores the urgency to expand women's access to higher technical education. The Special Rapporteur considered that "The knowledge, skills and competencies imparted by education are generally understood as primary vehicles for the empowerment of individuals and the promotion of social and economic development"[87] and that "States should pay particular attention to the empowerment of women and girls in the provision of technical and vocational education and training."[88]

Other than providing education, a new view is emerging that places universities and research institutions at the center of the development process.[89] The application of this concept also extends to other levels of learning, such as colleges, research and technical institutes, and polytechnic schools.

86 Report of the Special Rapporteur on the right to education, UN Doc. A/67/310, 15 August 2012, para.

87 Ibid., para. 8.

88 Ibid., para. 94.

89 Gregory Trencher, Masaru Yarime, Kes McCormick, Christopher Doll and Steven Kraines, "Beyond the Third Mission: Exploring the Emerging University Function of Co-creation for Sustainability," *Science and Public Policy* 41, no. 2 (2014): 151–179; Ka Ho Mok, "The Quest for Innovation and Entrepreneurship: The Changing Role of University in East Asia," *Globalisation, Societies & Education* 10, No. 3 (2012): 317-335.

Higher education and research institutions have therefore become a valuable resource for business, industry, and society.[90] In facilitating the development of business and industrial firms, universities can contribute to economic revival and technology-based growth in their regions.

Access to higher education and improvements in areas such as pedagogy are central to the realization of other human rights, especially those related to employment. In this respect, future discussions on technological innovation and human rights will need to shift attention from quantitative indicators and start to focus on the relevance and quality of the education. Discussions over the nature of universities and whether they adequately prepare the next generation of problem-solvers should equally be part of the discourse on technological innovation and human rights.

Entrepreneurship and creativity as expressions of human capabilities

Technological innovation is intricately intertwined with entrepreneurship—or the ability to identify and harness new opportunities to generate new economic or social value.[91] Entrepreneurship thrives in environments that guarantee open exploration, departure from standard practices, and willingness to take risks. Failure is usually an important source of lessons in such environments. Entrepreneurial growth is closely linked to expansion of liberties and generally does not do well in environments where human rights are suppressed or overly curtailed.[92]

Equally fundamental is the role of entrepreneurship in finding solutions to many of the world's pressing challenges. Tensions often emerge between the desire to create an environment that supports entrepreneurship and some of the excesses of enterprises that may go against public interest. As a result, there is considerable suspicion over the role of private enterprise.

90 R. Mazzoleni and R. Nelson, "Public Research Institutions and Economic Catch-up," *Research Policy* 36, no. 10 (2007): 1512–28.

91 Murray Hunter, "On Some Misconceptions about Entrepreneurship," *Economics, Management, and Financial Markets* 7, no. 2 (2012): 55-104.

92 John Gerard Ruggie, "Business and Human Rights: The Evolving International Agenda," *The American Journal of International Law* Vol. 101, No. 4 (Oct, 2007): pp. 819-840.

Indeed, there is extensive documentation of the negative impact of private enterprises on human rights, especially in extractive industries and outsourced businesses. Some of these studies view enterprises as instruments for oppressing the poor.[93]

Despite these concerns, it is important to recognize the importance of providing incentives that inspire people not only to help solve global problems, but also to contribute more effectively to society. Creativity and entrepreneurship are therefore critical elements of the technological innovation and human rights debate. Debates over the nature of incentives such as intellectual property protection will continue to be part of the public policy discourse. However, it is important to separate the incentives needed for creating a culture of innovation from the impacts of specific practices on society. This separation could enable society to expand the scope of intellectual property protection as an incentive for innovation while creating measures that enable society to benefit more widely from new ideas.

93 Janet Dine, "Companies," in *International Trade and Human Rights* (Cambridge: Cambridge University Press, 2005); Janet Dine and Andrew Fagan (eds.), *Human Rights and Capitalism: A Mulitdisciplinary Perspective on Globalisation* (Cheltenham, UK: Edward Elgar, 2006).

5. Science and technology diplomacy in the United Nations Secretariat

The UN is the most complex international organization ever created. Its structure and reach reflect the constantly-changing challenges facing the global community. Many of the issues arising from the interactions between technology, innovation, and human rights fall under its purview. In fact, many of the emerging issues form the regular agenda for debate in the various organs of the UN, especially in the General Assembly.[94] The issues end up on the daily agenda of the work of the UN Secretariat headed by the Secretary-General. Their complexity, scale, and underlying knowledge constantly change.[95] This makes it necessary for the Secretary-General to be regularly advised using the best available information. The UN is not just the apex of international diplomacy but also a guide for how other international organizations might approach emerging complex issues. It is for this reason that examining the role of the UN in international science and technology diplomacy becomes important.

Such advice should use practices that enhance procedural integrity to reduce knowledge uncertainty, biases, and conflicts of interest.[96] Equally important is ensuring that there is clear separation between the advice provided by the UN Secretariat and the operational mandates of the various UN programs, agencies, and organs.[97] Many of the operational bodies would need their own internal science advice mechanisms but they would not be in conflict with the work of the UN Secretariat.

The frequency with which issues related to technology, innovation, and human rights arise requires that the UN Secretary-General, the world's top diplomat, has the capacity within his or her secretariat to provide the best

94 National Research Council, *Knowledge and Diplomacy: Science Advice in the United Nations System* (Washington, DC: National Academies Press, 2013).

95 Calestous Juma, "UN's Role in the New Diplomacy," *Issues in Science and Technology* 17, no. 1 (2000): 37-38.

96 Michael J. Feuer and Christina J. Maranto, "Science Advice as Procedural Rationality: Reflections on the National Research Council," *Minerva* 48, no. 3 (2010): 259–275.

97 Calestous Juma and Yee-Cheong Lee, *Innovation: Applying Knowledge in Development* (London: Earthscan, 2005): 140-158.

available advice. Having such capacity will also enable the UN to serve as role model not only for other specialized agencies but for other international organizations that are involved in the global governance of interactions between technology, innovation, and human rights. Ironically, the history of the UN shows a steady retreat from having such in-house capacity though we are now at a time when the demand for science and technology diplomacy is on the rise.

A possible response could be for the UN Secretariat to establish an office that is similar and on par with the Office of Legal Affairs (OLA). For a variety of political reasons, the UN Secretariat does not have equivalent support. This is partly because governments, mostly from developing countries, conflated advisory with operational roles, thereby creating potential conflicts of interest, as they sought to strengthen the mandate of the UN to serve their national developmental needs. This problem was compounded by territorial conflicts within the UN regarding the locus of authority on science and technology issues.[98] UN agencies often believe that the creation of such an office would compete with their own operations.[99] The following examples show how the role of the UN Secretariat in providing science and technology advice has shifted over time.

From global science advice to developing country focus

Following the use of scientific expertise for military purposes during World War II, scientists and government official in the industrialized countries advocated that a new approach was needed to leverage science and innovation for the improvement of human well-being. Developing countries were starting to recognize the importance of science and technology. A combination of these interests led to the convening of the UN Conference for the Benefit of Less-Developed Areas held in Geneva in 1963. 1,665 delegates from 96 countries and international organizations attended the conference.

98 Klaus-Heinrich Standke, "Sixty Years of UN and UNESCO: Science and Technology in Global Cooperation: The Case of the United Nations and UNESCO," *Science and Public Policy* 33, no. 9 (2006): 627–646.

99 Calestous Juma and Yee-Cheong Lee, *Innovation: Applying Knowledge in Development* (London: Earthscan, 2005): 140-158.

It was made up largely of scientists and engineers who wanted to raise awareness among policy makers on the importance of science and technology for development.[100] The UN Advisory Committee on the Application of Science and Technology to Development (ACAST) was created in 1963.[101] Since ACAST only provided advice and did not offer policy guidance, the UN Economic and Social Council created the Committee on Science and Technology for Development with an initial 52 member states. To support the committees on the implementation of their advice, the UN created the Office of Science and Technology (OST) as a part of the UN Secretariat.

ACAST identified computers for development and protein malnutrition as important for developing countries. The topics were then emerging issues that involved a consideration of technological and human rights questions.[102] A number of developing country governments, however, felt that this work was not broad enough to capture their needs. They also felt that the existing UN structures were not robust enough to facilitate capacity building and technology transfer. These discussions led to the UN Conference on Science and Technology for Development in 1979 Vienna.[103] Unlike the Geneva conference that was dominated by technical experts, the Vienna conference was specifically designed to put governments in charge of the science and technology agenda. The conference was expressly convened to address political issues rather than scientific ones, in contrast with the 1963 Geneva conference.

The conferences created the UN Centre for Science and Technology for Development, the UN Financing System for Science and Technology for Development, and the UN Commission on Science and Technology for Development. One of the most substantive changes in the new UN organs was to narrow the focus of the role of science and technology to development by reporting to the Secretary-General through the Director-General for

100 Vladslav Kotchetkov, "Science and Technology Policy in the United Nations System: A Historical Overview," In Arvanitis, R. (ed.), *Science and Technology Policy*, Vol. 2 (Oxford, UK: Encyclopedia of Life Support Systems, 2009): 231-248.

101 Klaus-Heinrich Standke (ed.), *Science and Technology and Global Problems: The United Nations Advisory Committee on the Application of Science and Technology for Development* (London: Pergamon Press, 1979).

102 Guy Gresford and Bertrand Châtel, "Science and Technology in the United Nations," *World Development* 2, no. 1 (1974): 43-48.

103 Klaus-Heinrich Standke, "The Prospects and Retrospects of the United Nations Conference on Science and Technology for Development," *Technology and Society* 1, no. 4 (1980): 353-386.

Development and International Economic Cooperation. OST reported to the Secretary-General through the Department of International Economic and Social Affairs, whose mandate covered broader global issues. Opponents of the change, mostly from industrialized countries, preferred to have development be part of a global agenda and not be restricted to developing country interests.

The new institutional arrangements shifted from the initial focus on advice to seeking to be more operational in facilitating "technology transfer." In effect they deprived the UN Secretariat of the vital capacity to articulate science and innovation diplomacy within the UN system and beyond. Combining advisory and operational mandates led to conflicts between emerging economies and industrialized countries. This was partly because developing countries relied on governments to implement technology development projects while in industrialized countries the technologies were primarily owned by the private sector whose intellectual property rights were protected by law. It is also for this reason that intellectual property would emerge in the 1970s as one of the most contested areas of international technology and trade negotiations. These changes need to be understood in the context of the North-South negotiating atmosphere of the time when developing countries used the UN as a mechanism for facilitating resource flows to meet their development needs.

The slow return to global perspectives

Debate over the role of science and innovation advice in the UN Secretariat resurfaced following the adoption of the UN Millennium Declaration in 2000. To implement the declaration, the Secretary-General created the Millennium Development Goals (MDGs). The UN Millennium Project was launched by the Secretary-General to help translate the MDGs into action. This was done through a series of task forces for each of the goals. The MDGs did not set a goal for science, technology, and innovation. This was despite the fact that innovation was central to the implementation of the rest of the goals. It took the Task Force on Science, Technology, and Innovation (which I co-chaired) to elaborate the role of innovation in development through a flexible interpretation of a provision in Goal 8 on information and communications technologies (ICT).[104] Reference to ICTs was the last target of the last goal of the MDGs, suggesting the low priority the UN system gave to science and technology for development.

The Task Force on STI recommended the creation of an office of science and technology advice in the UN Secretariat. After a few years of discussion in the UN it became clear that the office was unlikely to be created. One of the arguments against the creation of the office was that it would duplicate the functions performed by the UN Educational, Scientific and Cultural Organization (UNESCO). This territorial response to new proposals has often been a stumbling block to expanding science and technology activities in the UN system.[105] Others argued that the proposal had come too late in the last term of UN Secretary-General Kofi Annan's last term and so the decision should be left to his successor.

Over this period, Annan was working closely with the Inter-Academy (IAC) to bring global perspectives to science and technology diplomacy. The IAC was created in 2000 as a multinational organization of science academies to prepare reports on global scientific, technological, and health issues. It sought to provide advice to national governments and international organizations. IAC issued several reports covering science and technology capacity,

104 Calestous Juma and Yee-Cheong Lee, *Innovation: Applying Knowledge in Development* (London: Earthscan, 2005).

105 Geoff Oldham, "Science and Technology Advice with the United Nations: Some Lessons from Past Experience," *Science and Public Policy* 33, no. 9 (2006): 647-651.

food security, and climate change. It is notable that this was done directly in consultation with the Secretary-General without the formal involvement of the UN Secretariat or its agencies.

Discussions on the importance of science and innovation diplomacy in the UN continued after Annan left office. His successor, Ban Ki-moon, established a Scientific Advisory Board to advise on the implementation of the Sustainable Development Goals, a global mandate transcending the focus on international development. He asked UNESCO to provide the secretariat and the UNESCO Director-General to chair the board. The mandate of the board was to *strengthen the interface between science and policy by ensuring that the latest scientific findings are reflected in high-level policy discussions.*[106]

The location of the board in Paris under UNESCO ensured that it could have immediate access to the infrastructure of the host organization. But the location also betrayed the underlying institutional politics. It played to the view that UNESCO was the authority in the UN on all scientific matters. This role, however, does not preclude the UN Secretariat from having its own capacity to address science and technology issues.

The case for strengthening science and technology diplomacy capacity in the UN Secretariat is even stronger today than it was in the 1970s. Global challenges have become more complex. This has prompted a number of countries around the world to strengthen their science and technology diplomacy capacity in foreign ministries. This is predominantly an industrialized country phenomenon that can be extended to other nations with inspirational leadership from the UN.

Given this history, the way forward might entail three measures. The first is to stress the universal role that science and innovation diplomacy can have in order to achieve global objectives, not just the interests of emerging countries. The second is the need to clarify the critical distinction between advisory and operational activities in the UN system. Having an Office of Science and Innovation Diplomacy in the UN Secretariat would facilitate interactions between similar offices in the UN as well as with member states.

106 Scientific Advisory Board, *The Future of Scientific Advice to the United Nations* (Paris: United Nations Educational, Scientific and Cultural Organization, 2016).

The UN would need to adopt a systems or joined-up approach where such offices interact regularly instead of the departmental model where they appear to be in competition. The third would be to ensure that the mandate of the new office is limited to providing advice to the Secretary-General in a way that is analogous to the functioning of OLA. This would help reduce anxiety among specialized UN agencies.

These measures could go a long way in strengthening science and technology diplomacy in the UN system through the office of the world's top diplomat. The absence of such in the 21st century is a major blind spot in global governance. The point here is not to reproduce the structures of the 1970s but to design a system that responds to contemporary global challenges. A failure on the part of the UN Secretariat to adjust to the imperatives of science and innovation diplomacy could lead to the erosion of its authority as science-based international organizations rise in global prominence.

Conclusion

Technological innovation is increasingly being recognized as a major force in shaping society. This has always been the case. The difference today is that technological ubiquity and rapid changes have made many of the impacts of technology on society more visible. Classical views about monolithic centers of diffusion of technology are crumbling in the face of new evidence indicating processes of technological diversification. Earlier notions founded on a linear flow of technology are giving way to more pluralistic approaches that include concepts such as "reverse innovation" developed to show the extent to which emerging markets are becoming new centers of global technological diffusion.[107]

These radical technological transformations have also disrupted traditional concepts such as "technology transfer" and call into question many of the normative arguments that have been used to find solutions to some of the world's most pressing challenges in fields such as health, food and nutrition, environment, and climate change. More specifically, interactions between technological innovation and human rights will need to be reexamined in light of new evolutionary dynamics and the important role that learning and human capabilities play in shaping new trends.

The human right to enjoy the benefits of scientific progress and its applications, proclaimed in the UDHR and reaffirmed in the major human rights treaties, should provide, as a UN special rapporteur recommended, "an enabling environment fostering the conservation, development and diffusion of science and technology."[108] As part of this right, she called on States to "promote the transfer of technologies, practices and procedures to ensure the well-being of people."[109]

As new global challenges unfold, new research questions will emerge around critical factors such as infrastructure, human technical competence,

107 Vijay Govindarajan and Chris Trimble, *Reverse Innovation: Create Far from Home, Win Everywhere* (Boston: Harvard Business School Review Press, 2012).

108 Report of the Special Rapporteur in the field of cultural rights, Farida Shaheed. The right to enjoy the benefits of scientific progress and its applications, UN Doc. A/HRC/20/26, 14 May 2012, para. 25.

109 Ibid., para. 74 (k).

and entrepreneurship. These and other new issues will become the locus of future explorations on the extent to which the scope of both technological innovation and human rights continue to expand. One significant implication of this view is that the locus of discourse on technological innovation and human rights will no longer be restricted to traditional multilateral institutions and concepts such as "technology transfer." Technological ubiquity and diversity are already shifting much of the debate to new forums that involve more non-state actors. Similarly, the emergence of global value networks are also providing emerging economies with new opportunities to build national capability as part of a more complex global knowledge system that cannot be explained by the linear flows implied in the concept of "technology transfer."[110] The future is certainly open to new possibilities for experimental minds.

110 Rasmus Lema, Ruy Quadros and Hubert Schmitz, "Reorganising Global Value Chains and Building Innovation Capabilities in Brazil and India," *Research Policy* 44, no. 7 (2015): 1376-1386; F. Zhang and Kelly Sims Gallagher, "Innovation and Technology Transfer through Global Value Chains: Evidence from China's PV Industry," *Energy Policy* 94: (2016): 191-203.

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