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Frameworks for Evaluating Technology Transfer

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The Necessity for Frameworks

Technology can help us to keep air and water clean, to educate ourselves and others, and to make our lives more comfortable. Technology, however, has in the ears of many, a threatening ring. Whether technology serves human well-being depends on its usage. Dust-covered computers, abandoned factories, underutilized hospitals, chemical plants polluting our environment, nuclear power threatening our health—negative instances of technology application abound. To obtain greater positive results, technology has to be applied and transferred according to criteria that enable us to assess potential benefits and risks associated with the technology. Technology transfer includes tangible and intangible assets, such as computer chips and the knowledge transferred by exchange students. Simon defines the globalization of technology as "the development and diffusion of critical scientific knowledge and technological capabilities beyond the borders of a limited number of so-called advanced nations."[1]

Too often those in charge of technology transfer are led more by shortsighted motives, such as national, corporate, or individual prestige, rather than by a long-term development oriented approach. In order to induce responsible technology transfer, one has to establish a framework according to which one examines possibilities for technology transfer, and then select the most appropriate options for a given context. We need theoretical frameworks to analyze technology transfer, and screen it according to its potential use and likely impact within a given environment. This essay emphasizes constructive approaches that can provide communities with a framework to arrive at informed decisions about technology in their midst. Communities in the United States are not alone in making important policy choices, and we can learn from other communities—be they villages or nations—from all over the world. In order to highlight power balances that exist both domestically and internationally, special attention will be paid on how to make technology transfers a win-win situation for all parties involved.

Toward a Constructive Framework: Analyzing Appropriate Technology

When evaluating transfers under the premise of utilizing technology to make life for human beings around the globe more worthwhile, neither the usually adopted stances of polite neutrality nor ideological blinding contribute constructively to the debate. What is needed are positions that evolve dynamically in exchange with others, and that are laid open when discussing technology. The notion of appropriate technology implies that it has to be adapted to the circumstances under which it is supposed to operate. By the same token, the community needs to be able to absorb the technology. In cases where absorptive capacity is lacking, technology is not exploited to its full and positive advantage. In extreme cases, it may sit idle and just rot away, if it is a tangible item. A common example from the early period of modern technology transfer is the one of tractors in the former Soviet Union, Latin America, and Africa, which rusted unused due to an insufficient supply of spare parts. We find other cases of underutilized technology in everyday life; thus, can you name the function of all the keys on your stereo? Do you need that high-powered car to see your friend just around the corner? How many applications of your computer program do you employ?

Some of the most decisive technology transfers happen in the form of know-how, for example through academic exchange and job training. We all know (and excuse) the underutilization of our minds, of computers, and of cars. After all, these are items from largely individual contexts, so we are free to decide on how far we exploit the capacities of these personal items. The problem assumes a more serious nature when it comes to the utilization of common goods, such as government education, scientific research, and national defense. Both through our tax dollars and the goals for ourselves and families, we have a personal stake in those technologies, while our influence is in most cases only indirect; for example, through voting and grassroots initiatives. More often than not, reverting to appropriate action is complicated by our lack of knowledge about the technology. In these cases, we could expand our absorptive capacities. At the very least, we have to know the origin, use, and potential implications of a technology that is going to be transferred into our or another community (a dichotomy between "us" and

"them" does not really exist anymore, taking into account the global character of outcomes of technology transfer such as pollution, but also human suffering which has, or should have, universal appeal). Then, we need to be able to refer to a framework within which to evaluate the technology in its future context.

Very often, however, failures in technology transfer are not due to a lack of absorptive capacity. Rather, they occur due to a lack of concern for the particular circumstances in which technology is to be applied. An infamous example of an absence of case-specific contemplation is a project carried out by the German technical cooperation with the Ivory Coast, which aimed at achieving more competitive prices for beef. Traditionally, the animals were being driven to the coast where they were slaughtered before shipping their meat through the coastal infrastructure. In order to halt the loss of the cows' muscle and fat tissue due to their walking all the way to the coast, a slaughter house was erected in the country's interior, close to the cows' pastures. The building posed a technological model of the ideal slaughter house. It conformed to all engineering standards up to the norms of its nuts and bolts. It was exemplary from the foundation to the snow-proof roof. But, snow-proof roof in a West African country?

Yes, the German engineers and agricultural specialists had conscientiously transferred their technology. They even provided refrigerated trucks to transport the beef to the coast. What they had not taken into account was the might of the tropical sun compared to that of Western Europe. Due to the Ivorian climate and roads, the trucks needed maintenance sooner than expected, but there were no spare parts available. Needless to mention, the transferred technology, perfectly appropriate in the West European context, was a failure when put to the test in West Africa. It is indispensable to go beyond the narrow framework of individual disciplines, in this instance engineering and agronomy, in order to employ and apply technology effectively and efficiently in a given environment. The fact that all too often technology is not adapted to the realities in the southern hemisphere reflects the global imbalances in resources, and in expenditures used for research and development.

The lack of economic and political clout presents developing countries from getting their share of the global technology pie, which is largely distributed via technology transfers. This further limits their influence, because in order to attain regional and global leverage, a nation needs to offer something that makes it attractive to others. The worldwide distribution of research and development facilities, an important indicator for technological prowess, has improved only marginally from the early 1970s when less than three percent of global research and development expenditures were put forward by developing nations.[2] In today's global marketplace, a country receives more recognition if it is a worthwhile spot for investors, of course. Many developing economies urgently needing investment, lack the infrastructure to attract it. Ghana, for example, loses annually billions of dollars in foreign direct investment due to its poor communication infrastructure.[3] Potential investors leave the country in droves after they pick up the receiver to place a call and find themselves either not getting any line at all or shouting into the phone due to bad transmission.

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Alternative sources of energy are another instance of technology adapted to local circumstances, involving more modern and advanced technologies than those most widely used. Distributing electricity via cables from a central power plant is cheap and efficient in most industrialized nations due to a pre-existing and well-maintained network. In many countries in the southern hemisphere, it is more cost-efficient to supply electrical power through solar energy than to install an electricity network and wait until it has amortized itself. Solar technology has so far been produced in industrialized countries, for example by Enron in the United States and Siemens in Germany. Since the assembly of the photoelectric panels is fairly labor-intensive and does not require much training, it could easily and profitably be outsourced to developing economies. Ideally, solar panel plants would be located in countries that produce major ingredients to the panels such as copper, namely Zambia, Zaïre, and Chile.[4] The countries to which the technology is transferred could—in addition to the benefits of the transfer itself that include knowledge about a starter technology with immense potential—gain from tax generation, employment creation, intersectoral linkages, value-added to raw materials through a high-earning industry, and opportunities on domestic and export markets.

These examples point to the fact that the notion of appropriate technology in its twisted version only serves companies in industrialized countries to dump their outmoded technology onto markets in the southern hemisphere, rather than to advance the latter's development. The foregoing cases do demonstrate that there is more reason for optimism for developing economies than often assumed: a decisive factor in Japan's and Germany's current economic might is the depletion of their industries due to the reparations they had to pay for their crimes against humanity during World War II. The necessity to start from scratch caused them to acquire the most advanced technology once they had regained some financial liquidity, and thus overtake the war's victors in the ensuing technological and economic race. At the same time, one has to stress that Germany's and Japan's technological, and therewith economic and political ascendancy was based on former strength in these areas, and was accompanied by strong emphasis on human capacity building. Many African regions can likewise look back on a tradition of ingenuity and

technological achievement, although it had been interrupted through colonialism.

From Appropriate to Holistic Technology

The theorem of appropriate technology states that a technology needs to be adapted to the circumstances in which it is to be applied. The nation, community, company, or individual must be able to absorb the acquired technology, that is, handle it in an apt manner and thus assume ownership of it. This involves applying technology to the particular circumstances under which it is needed. The theory of appropriate technology is sometimes misunderstood as implying the simplest technology. This idea still reigns the heads of those concerned with technology transfer, particularly in industrialized countries. Appropriate technology, however, means the best adapted technology. Equating this automatically to unsophisticated technology reflects the presumptuous mindset of planners in industrialized countries rather than the actual condition of education in industrializing economies. Certainly, in developing nations there often exists a critical lack of financial resources, spare parts, and training opportunities. That, by any means, forces technicians and entrepreneurs to be more creative and proactive in finding alternatives. These alternatives in many cases involve leapfrogging over conventional models still widely used in so-called industrialized countries: "the more stringent the criteria, the higher the level of technology needed to resolve a given problem."[5] This is really the theory of appropriate technology in its purest conceptual sense. Kodama calls it "holistic technology." Holistic technology employs "autonomous, decentralized systems" that are adapted to the fragmented infrastructure in developing countries. This is where those involved with technology have to take a stance: spreading the theory of holistic technology and continuing to put it into practice opens multiple highways to development.

One of the most important implications would be, if coupled with adequate financial resources, an eventual reversal of the flight of highly qualified scientists and engineers from developing economies. They would be induced to stay or return if they were presented right in their home countries with the intellectual challenges they are ready to tackle.

One of these challenges includes the provision of power and the conservation and storage of food. Although Kodama clearly points into the right direction with his definition of holistic technology, he goes off the deep end in his enthusiasm for what is technologically feasible. He cites the radiation of food to retard spoilage as a positive example for holistic technology.[6] Experts must not fall into the trap of what I term "scientific fallacy": to carry out what seems scientifically doable, even though ethically undesirable. Considering that radio-chemistry of food is by no means proven as healthy for humans, we have to be on guard against attempts to use underprivileged populations as guinea pigs. This of course is one of the drawbacks of the newest technology: it is not always in all aspects proven to be safe.

Nonetheless, technology transfers are often welcomed because they overcome practical constraints that severely inhibit social, political, and economic development. In the case of cellular telephones, for example, many decide the trade-off between possible health risks and the necessity to communicate in favor of the latter, especially where no viable alternatives are available. In Ghana the complete inadequacy of the public telephone system ensures spectacular success for two mobile phone companies that have been allowed to operate in the country in the course of the structural adjustment's divestiture and dismantling of monopolies. The problems associated with maintaining a cable network of telephone lines have prompted experts to speak out against AT&T's plan to surround the African continent with telephone cables, on the grounds that the corporation strives to create a monopoly for itself while capturing the diminishing returns from the last phase of the cable's product life cycle. In addition, positioning a cable around the continent would aggravate the problem existing since colonialism of having infrastructure point into and out of Africa, without connecting African nations among each other. Callers from francophone West Africa, for example, find it easier to get through to Paris than to neighboring anglophone countries.

Instead of exacerbating persistent shortcomings, it would be more appropriate to employ holistic technology, technology that is adapted to the factors under which it operates. Holistic technology bridges current shortcomings and leads to new opportunities. Satellites for global communication networks are an illustration of holistic technology. This is why the international struggles for the most advantageous satellite positions in the ether were carried up to the General Assembly of the United Nations. Not surprisingly, the financially better endowed nations of the north won out. The limited access to satellites is one of the causes for the phenomenon of information poverty in the southern hemisphere.

A means to overcome "information poverty" is to switch to advanced technologies adapted to the given constraints, which again points to holistic technologies. Physicians in western Zambia, for example, obtain specialist advice over e-mail, while health workers check via e-mail what drugs are available where, thus saving transaction costs in the form of communication and transport expenditures. Instead of reaffirming one-way communication and power imbalances, modern technology may be effectively utilized to bring north and south together. In the global market place, farmers in developing countries can sell their commodities directly to consumers all over the world, thus avoiding to pay transaction costs to traders. Centers for technology communication can be located in communities, such as the recently mushrooming bars with access to the Internet, or, on a wider scale, in countries as a whole. Singapore is an instance of a nation which presents itself as a middle office between developing and industrialized nations. Singapore offers to fulfill a broker function, with northern countries outsourcing work to her, and her subcontracting

to developing countries.[7] Such a gateway-position is a potentially powerful one, not only technologically, but also economically and politically.

In today's increasingly interconnected world, technological frameworks have to be contemplated under inclusion of political and economic realities.[8] This holds a lesson for countries (communities, companies) still stemming their feet against the tide of technological transfers. Imposing regulatory, economic, and political obstacles means incurring an unreasonable amount of opportunity cost upon one's administrative and monitoring institutions, a strain on budget and human resources which shows particularly in developing economies.[9] Since processes of technology transfer are multidimensional, regulations cannot effectively prevent them from taking place in any event.[10] People who have set their mind on bringing in some undesired technology will still do it, while the nation misses out on the opportunities that come with early technology transfer.[11] The immense direct and indirect costs associated with controlling technology would be more wisely spent managing it under anticipation of trends that can be beneficial to the domestic economy—vital especially in countries pursuing structural adjustment—as to global growth and technological advance.

Notes

[1]Denis Fred Simon, "International Business and the Transborder Movement of Technology," *Technology Transfer in International Business.* (New York and Oxford: Oxford University Press, 1991), 6.

[2]Jan Annerstedt, "Measuring Science, Technology, and Innovation," *Uncertain Quest.* (United Nations University Press, 1994), 96.

[3]Figure extrapolated from author's field research in West Africa, May-September 1995. Although top officials of Ghanaian government institutions now see the necessity of infrastructural preconditions to investment, implementation lags far behind their plans. This is because no means has yet been found to demonstrate potential benefits from the changes to those further down the hierarchical ladder, and results in persisting barriers to the transfer of technology and capital. The middle and lower ranks of customs, for example, ignore new legislation that permits the free movement of devices which serve educational and investment purposes such as computers. They see nothing wrong with unlawfully retaining laptops for months, until a bribe has been paid that amounts to the price of a new computer. Like Ghana, many societies in developing countries find themselves in a phase of transition, which splits companies and institutions in adherents of the old versus those of the new. Results of author's field research, observations made during "Investor Roadmap Workshop" at the Ghana Investment Promotion Centre, (Accra: 19-20 July 1995).

[4]William Moomaw, personal interview. (Medford, MA: Fletcher School of Law and Diplomacy, 17 October 1995). Information on the African copper belt in the atlas by Werner Hilgemann, Günter Kettermann, and Manfred Hergt, *dtv-Perthes-Weltatlas: Großräume in Vergangenheit und Gegenwart: Afrika*, second edition. (Darmstadt: Deutscher Taschenbuch Verlag, and Justus Perthes, 1984), 26-27.

[5]Fumio Kodama, "Emerging Trajectory of the Pacific Rim: Concepts, Evidences, and New Schemes," *The Emerging Technological Trajectory of the Pacific Rim.* (ME Sharpe, 1995), 31.

[6]Ibid.

[7]BBC on National Public Radio. (17 October 1995, 22:37 United States Eastern Standard Time).

[8]The author of this article is concerned with alleviating information poverty in the southern hemisphere. She is involved in building a network of practitioners and scholars on several continents who exchange information and work together on issues of development and technology. Anyone interested in exchanging ideas should contact the author.

[9]Thomas Lee and Proctor Reid (Eds.), *National Interests in an Age of Global Technology.* (National Academy of Engineering, 1991), 52. See also Denis Fred Simon, "International Business and the Transborder Movement of Technology," *Technology Transfer in International Business.* (New York and Oxford: Oxford University Press, 1991), 17.

[10]David J. Teece, "The Market for Know-How and the Efficient International Transfer of Technology," *Annals of the American Academy of Political and Social Science*, (November 1981), 458:81-96.

[11]Those countries that innovate or first adopt a new technology are usually first in diffusing it and thus profiting from it. Kazmierz Z. Poznanski, "International Diffusion of Steel Technologies: Time-Lag and the Speed of Diffusion," *Technological Forecasting and Social Change*, Vol. 23 (1983):305-323.

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