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Nanotechnology and the Developing World: Will Nanotechnology Overcome Poverty or Widen Disparities?

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ABSTRACT

Nanotechnology is thought to be the next technological revolution. Its defenders consider it to be a solution to the main problems that developing countries face. In this article, Doctors Noela Invernizzi and Guillermo Foladori argue that this optimistic view overlooks the reality that science and technology development are not neutral and willing processes, but depend on the social context in which they develop. Invernizzi and Foladori challenge what they see as overly optimistic assessments within recent articles concerning nanotechnology applications thought to have the most impact on developing nations. Invernizzi and Foladori argue that attempts to list nanotechnology applications which may benefit people in poorer nations can be seen as only a starting point in a much larger and important debate which seeks to challenge the dominant socio-economic hierarchies in which nanotechnology development and application actually occur. By recognizing these historical mistakes and realities, the nanotechnology community can help to avoid repeating the mistakes of the pharmaceutical and biotechnology industries to help nanotechnology become a tool which can alleviate disparity rather than widen it. Whether nanotechnology can ultimately alleviate poverty depends on whether social technologies are productively used to actually address the needs of the poor.

INTRODUCTION

One of the most hotly debated issues, and one of the most difficult to discern in advance, in the growing discussion on nanotechnology, is its possible effects on poorer countries and less fortunate

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segments of the population. There are optimistic stances, wherein nanotechnology is considered to be a panacea, and there are pessimistic viewpoints which suppose that the gap between rich and poor will widen as a result of the diffusion of this kind of technology. The debate on these different stances, supported by theoretical arguments and empirical data, is fundamental for arriving at a balanced viewpoint of the situation.

In early 2005, several influential articles claimed that nanotechnology is a viable alternative for resolving most of the Millennium Development Goals of the United Nations.[1] Some scholars have even attempted to list the top ten nanotechnology applications that will most benefit those in poorer nations. While it is undoubtedly useful to determine which aspects of nanotechnology promise the most to poorer nations in terms of application, the international community needs to question this optimism, placing these new technologies in their social context.

I. NANOTECHNOLOGIES AS DISRUPTIVE TECHNOLOGIES

Nanotechnology manipulates atoms and molecules to make or build things (or living beings). One may imagine a laboratory which, combining suitable molecules in quality and quantity could create electric drills. Although this is theoretically possible, it would take some time, at least until there were nanobots that could do the job by themselves. But this will be at a later stage, if ever. At the moment, what can be made are nanoproducts, in which scientists manipulate matter at the nanoscale to give them special or more efficient uses. Witness the introduction of nanotextiles in recent times.

According to the Nanotech Report, [2] among the first products commercialized in 2004 with nanotechnological content were the following: thermal shoes (Aspem Aeogels); dust and sweat-repelling mattresses (Simmons Bedding Co.); more flexible and resistant golf clubs (Maruman & Co.); personalized cosmetics for different ages, races, genders, types of skin and physical activities (Bionova); dressing for cuts and burns that prevent infections (Westain Corporation); disinfectants and cleaning products for planes, boats, submarines, etc. (EnviroSystems); spray that repels water and dirt that is used in the building industry (BASF); treatment for glass to repel water, snow, insects etc. (Nanofilm); cream that combats muscular pain (CNBC); and dental adhesives that set the tooth crown better (3M ESPE). Lux Research, a company dedicated to the study of nanotechnology and its business, estimates that the sale of articles with nanoparticles will surpass the mark of $500 billion in 2010. [3]

At least four aspects characterize nanotechnology as a great new development. First, it revolutionizes the manufacturing process. Nanotechnology builds from the smallest number of atoms and molecules to make the biggest final product—the bottom-up process. Nanotechnology can also reverse the process—instead of starting with physical matter as it is found in nature, according to its own structures, and reducing it to the size of the objects to use as has been done until now—the top-down process. Despite this road being familiar in chemical processes, the novelty is that, now, atoms and molecules can be *directly manipulated* to manufacture products.[4] This constitutes a novelty in the history

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1 Fabio Salamanca-Buentello et al., *Nanotechnology and the Developing World*, 2 PLOS MED. E97 (2005), *available at* http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=15807631 (last visited June 4, 2005).

2 Forbes/Wolfe (Editorial). *Top 10 Nanotech Products of 2004*. NANOTECH REPORT, 3(12), 1, December 2004.

3 Stephen Baker & Adam Aston, *The Business of Nanotech*, BUS. WK., Feb. 14, 2005, at 64. As a reference, all exports from Latin America and the Caribbean in 2004 totaled $461 billion; foreign debt in Latin America and the Caribbean in 2004 totaled $721 billion. ECON. COMM'N. OF LATIN AM. & CARIBBEAN ("ECLAC"), STATISTICAL YEARBOOK FOR LATIN AMERICA AND THE CARIBBAN, 2004, *available at* http://www.eclac.cl/publicaciones/Estadisticas/4/LCG2264PB/p1_2.pdf (last visited June 7, 2005).

4 RS&RAE / Royal Society & The Royal Academy of Engineering. NANOSCIENCE AND NANOTECHNOLOGIES: OPPORTUNITIES AND UNCERTAINTIES. The Royal Society & The Royal Academy of Engineering. July 29, 2004. http://www.nanotec.org.uk/finalReport.htm (last visited February 12, 2005).

of humanity and a new way of thinking in the world. Its consequences are unlimited. It is even conceivable to think that a process of production that manufactures by summing up molecules will, in theory, generate no waste.

Second, at this nanoscale level, there are few differences between biotic matter and abiotic matter in that it is potentially possible to apply biological procedures to material processes or interfere with materials in living bodies, adapting the latter to certain purposes or offering certain advantages, or also creating artificial life to perform specific tasks. One example would be a way of allowing the body to rest without sleep, which would be very useful in war and other activities that are very physically or mentally demanding.

Third, nanoparticles may have physical and chemical properties (conductive, electric, mechanical, optical, etc.) which differ from the same elements on a macroscopic scale. By changing the physical properties of the matter, possibilities arise that surprise and excite scientists who are dedicated to this study. Many nanomaterials that are on sale offer great advantages in this way. Carbon nanotubes, for instance, are harder than diamonds and can be up to fifty to a hundred times stronger than steel.

Finally, nanotechnology combines several kinds of technologies and sciences such as information technology, biotechnology and materials technology. The latter is not a lesser element if we consider that the true development of nanotechnology will require a totally new professional education which will require rethinking schooling, maybe from the primary level.

The potential benefits of nanotechnology are impossible to calculate. Here we can mention a few of the more probable. In the field of health, it could increase the quality and length of life. Nanosensors, incorporated into the organism, could travel through the bloodstream similar to the way a virus does and detect illnesses before they spread to the rest of the body and combat them efficiently. In the future, drugs may no longer be generic for all people, but may be specifically designed according to the genetic make-up of the individual and his/her gender, age, diet, etc. Ageing mechanisms could be retarded and even reversed, with the human lifespan being lengthened significantly. With these artificial sensors, a person could become a bionic being, improving her biological capacities and developing others. Some even envision nanotechnology applications that will improve human perception and ability at fundamental levels. The field of prostheses is also among the most promising.

In the materials field, one novelty will be intelligent nanoparticles. Your wardrobe, for example, could be reduced to one single article. The item of clothing you have will react to changes in temperature, rainfall, snow, sun, etc., keeping the body always at the programmed temperature. Furthermore, it will repel sweat and dust, which will mean that it will not require washing. As if this were not enough, it would stop bacteria or viruses from penetrating it, protecting it even from possible bioterrorist attacks. In the case of an accident, your clothes would have healing effects, offering first aid. The same that applies to clothing could be adapted to certain dwellings and modes of transport. Another novelty is that carbon nanotubes are stronger than steel and only 1/6 of its weight. This will have a special impact on the aerospace, construction, automobile industries and many others.

The field of computer science will be one of the earliest industries and will enjoy the most revolutionary change. Computers can be a hundred times faster and much smaller and lighter, and can be custom build according to the tastes of the buyer in terms of design, size, shape, color, smell, resistance, etc. Prototypes with built-in sensors will speed up designs, adapting to flexible production processes in different parts of the world, overcoming many of the barriers that distance now imposes. The old “just-in-time” production mode will become obsolete and may very well become the “as-you-need” mode of production. The possibilities for monopolistic concentration of production (global business enterprises) will multiply.

The combination of computerized systems, chemical laboratories, miniature sensors and living beings adapted to specific functions will revolutionize medicine (e.g., lab-on-a-chip) and also provide rapid solutions to the historical problems of contamination. Small bacteria with sensors may be able to consume bodies of water that have been contaminated by heavy metals, or decontaminate the atmosphere in record time. Nanocapsules with combined systems of sensors and additives will revolutionize the industries of lubricants, pharmaceuticals, filters, etc.

Nanotechnology may become a disruptive technology that will make obsolete the current competitive technologies, once established and entrenched in economies around the world. The social and economic effects on the international and national levels are difficult to foresee, but an effort must be made at this critical juncture in order to reduce the possible negative or unwanted consequences that have historically accompanied such dramatic transformations.

II. NANOTECHNOLOGY AS A SOLUTION FOR THE POOR?

Despite the voices that warn of the possible negative consequences or risks of nanotechnology, there are others that suppose that the new technology will be beneficial to everyone, including the poor. In this light, the recent U.N. Millennium Project Report, *Task Force on Science, Technology and Innovation*, puts forward the idea that nanotechnology will be important to the developing world because it harbors the potential to transform minimal work, land and maintenance inputs into highly productive and cheap outputs; and it requires only modest quantities of material and energy to do so.[5] However, these same qualities could be seen as harmful because poor countries have abundant labor, and, in many cases, land and natural resources. In this way, nanotechnology may cause displacements and disruptions in the economies of poorer nations.

Reasoning in a purely technical and linear fashion, any country could theoretically join the nanotechnology wave. An effort for public funding may create the bases to establish specific nanocomponent industries to meet determined needs; or it is possible that businesses with a scientific tradition might justify a technological leap at a relatively low cost. This seems to be the opinion of the authors of at least one article[6] that has received a great deal of attention from the international scientific press.[7] Fabio Salamanca-Buentello and several of his colleagues from the Joint Center for Bioethics at the University of Toronto introduce nanotechnology as the solution to many problems in developing countries.[8] They understand the effort for harnessing nanotechnology in developing countries as a demonstration of the willingness of such countries to overcome poverty: ". . .we show that developing countries are already harnessing nanotechnology to address some of their most pressing needs."[9] After interviewing sixty-three experts in nanotechnology from several developed and developing countries, the authors identified the ten main nanotechnologies that could provide a solution to such problems as water,

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5 Juma, Calestous & Yee-Cheong, Lee (Coord.). INNOVATION: APPLYING KNOWLEDGE IN DEVELOPMENT. UN Millenium Project Task Force on Science, Technology, and Innovation. London, Sterling Va.: Earthscan, 2005.

6 Salamanca-Buentello et al, *supra* note 1.

7 Catherine Brahic, *Developing World 'Needs Nanotech Network'*, SCIDEV.NET (June 4, 2005), at http://www.scidev.net/News/index.cfm?fuseaction=printarticle&itemid=1923&language=1 (last visited June 4, 2005); Charles Q. Choi, *Top 10 for Developing World*, UNITED PRESS INT'L (Apr. 18, 2005), *available at* http://www.upi.com/view.cfm?StoryID=20050415-114140-8159r (last visited June 4, 2005); *Taking Nano to the Needy: A* Small Times *Q&A with Fabio Salamanca-Buentello*, SMALL TIMES, June 15, 2005, at http://smalltimes.com/print_doc.cfm?doc_id (last visited June 16, 2005).

8 It must be noted that the authors explicitly recognize that science and technology are not enough: "Like any other science and technology waves, nanoscience and nanotechnology are not 'silver bullets' that will magically solve all the problems of developing countries; the social context of these countries must always be considered." Salamanca-Buentello *et al.*, *supra* note 1, at 2. The authors do, however, visualize science and technology investments and scientists involved in developing countries as an indicator of willingness to overcome poverty. *See id.*

9 Salamanca-Buentello *et al*, *supra* note 1, at 1.

agriculture, nutrition, health, energy and the environment.[10] The technologies range from energy production and conservation systems, with sensors that will increase agricultural productivity and the treatment of water, to the diagnosis of diseases. In the article, the creation of a Global Fund is proposed for the development of these technologies for all developing countries. Overflowing with good intentions, the proposal reflects the mechanical idea that if a problem can be identified correctly, then all that has to be done is to apply a suitable technology, and it will be solved. Most of the examples used do not take into account the reality that the relationship between science and society is much more complex than identifying a technology and its potential benefits.[11] Let us put some of the examples in their social context.

1. The Experience of Poorer Nations with HIV/AIDS Pharmaceuticals

Salamanca-Buentello and colleagues suggest that quantum dots could detect HIV/AIDs molecules in the early stages, thereby facilitating the treatment of AIDS and reducing the number of new cases. While quantum dots may, in fact, provide a useful solution to the HIV/AIDS crisis in developing countries, Salamanca-Buentello's article does little to place this novel technology into the historical experience of poorer nations with advances in the medical field more generally.

The authors seem to forget the story of the last several years, which has been one of seemingly open war between multinational pharmaceutical corporations and the governments of countries that intended to manufacture antiretrovirals against AIDS. In this conflict, the World Trade Organization ("WTO") and the Commercial representative of the United States have systematically played the role of front-line soldier for these corporations. The rigors of the patenting system have used monopolist economics to drive medicine pricing for the last twenty years. This makes it impossible for poor people to buy medicine from companies that hold patents. Experience over the last several years has shown that when an epidemic occurs, some countries could not afford to cover the cost of remedies very much needed by people within these poorer countries.

One of the most alarming historical cases, illustrating the behavior of the multinational pharmaceutical corporations that tends to undermine public health, was the action brought in 2001 by thirty-nine of the major pharmaceutical corporations against the government of South Africa. In that case, several major pharmaceutical corporations prevented the government of South Africa's producing generic medicine for AIDS treatment. A lawsuit over the matter was soon filed. The lawsuit, which the South African government won, showed total insensibility to human rights on the part of the pharmaceutical corporations. The statements of one of the pharmaceutical company's representatives bore out this insensitivity. According the reasoning of certain pharmaceutical companies, the court's ruling allowing the government of South Africa to produce affordable generic medicine could have a precedential effect allowing other governments to cheaply develop generic medicines: "while South Africa may represent less than 1% of world drug sales, the precedent of allowing a government to step on drug companies' patent rights would have far-reaching effects, beyond the questions of cost and crises."[12]

Nanotechnology products are already being patented, typically by the most important and largest corporations in the world. A patent in the U.S. costs $30,000 in legal bureaucracy, and a worldwide patent may be as much as a quarter of a million dollars.[13] For an underdeveloped country it is very difficult to develop any medicine for which there is an important market (as is the case of AIDS) if we take in account the economic and legal medicine market's international "war," as well as the bureaucratic restrictions which drive up costs and limit reduce availability. This story has a simple moral: technology

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[10] "In order to provide a systematic approach with which to address sustainable development issues in the developing world, we have identified and ranked the ten applications of nanotechnology most likely to benefit developing countries. We used a modified Delphi Method. . .to identify and prioritize the applications and to achieve consensus among the panelists." Salamanca-Buentello *et al*, *supra* note 1, at 3.

[11] D. Sarewitz et al., *Science Policy in its Social Context*, PHILOSOPHY TODAY, 2004 Supplement, at 67.

[12] Robert Block, *AIDS Activists Win Legal Skirmish in South Africa*, WALL ST. J., Mar. 17, 2001, at A17.

[13] A. Regalado, *Nanotechnology Patents Surge*, WALL ST. J., June 18, 2004, at A1.

is produced in a given social context, and the efficiency and implications of its application depend on that social context.

2. The Experience of Poorer Nations with Biotechnology

Salamanca-Buentello and his colleagues identify nanotechnology as the solution to five of the eight Millennium Development Goals of the United Nations. Among these supposed solutions are nanosensors and nanocomponents to improve the dosage of water and fertilization of plants. With this technology, it would be possible to reduce poverty and hunger in the world. Simply identifying a potentially useful application, however, overlooks the clear historical experience of poorer countries. Not so long ago, in the 1980s, genetically modified organisms were hailed as the solution that would put an end to hunger and poverty. However, genetically modified organisms ended up being used mainly in developed countries; and three out of four patents are today in the hands of four large multinational companies. There has been no improvement for Third World countries; quite the contrary, transgenics turned up where they were not wanted or expected, as was the case of the contamination of corn in Oaxaca, Mexico. In the case of genetically modified organisms, commercial and technological dependence was increased, not reduced.[14] This historical example could well foreshadow the path that nanotechnology takes in worsening existing gaps between the developed and less developed world unless steps are taken now to avert a repeat of history.

It is far from a foregone conclusion to assume that agricultural nanotechnology will follow the controversial road taken by genetically modified organisms. However, avoiding such a situation requires a healthy debate concerning the possible social, economic and political implications in real time.[15] Michael Mehta highlights three lessons for nanotechnology that should be learned from the experience with biotechnology: (1) to provide legislation on nanotechnology products in such a way that public participation will not be undermined by science-based assessment; (2) to label products with nanocomponents in order to gain acceptance with the corresponding empowerment of the consumer; and (3) to use the precautionary principle in a way that could prevent serious risks without limiting the possible development of these sciences.[16]

One limitation with the above analysis is that nanoproducts are already facing political and economic pressure, in part responsible for building the nanotechnology revolution; and past experience, so far, plays too limited a role in this process. And the difficulty presented by efforts to categorize and regulate nanotechnology frustrates ready-made solutions for the industry to avert the problems encountered by the biotechnology industry with genetically modified organisms. Take the following two statements as an example: nanotechnology products face the paradox that they are (1) elementary particles of known chemical elements; and (2) manipulated in a way that is not natural. As for the first statement, nanoproducts do not always need to go through drug trials and registration. Regulations seem not to accompany the speed of technical improvements. A document by the Woodrow Wilson International Center for Scholars is explicit on the contradiction between the reality of nanoparticles and the ambiguity of the American regulatory standards, and it concludes on the need to reform the *Toxic Substance Control Act* ("TSCA").[17] Considering that first statement above, then, nanoproducts are nothing new; rather, they are part of nature.

The clear implication of the second statement is that nanoproducts are being patented as new elements which are not found naturally in that state. The following quote exemplifies this paradox: "[i]t

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[14] M. SCHAPIRO, BLOWBACK IN GENETIC ENGINEERING *in* A. LIGHTMAN, D. SAREWITZ & C. DESSER, LIVING WITH THE GENIE (2003).

[15] David H. Guston & Daniel Sarewitz, *Real-Time Technology Assessment*, 24 TECH. IN SOC'Y 93 (2002).

[16] Michael Mehta, *From Biotechnology to Nanotechnology: What Can We Learn from Earlier Technologies?*, 24 BULL.OF SCI., TECH., & SOC'Y 34 (2004).

[17] WOODROW WILSON INT'L CTR. FOR SCHOLARS, NANOTECHNOLOGY & REGULATION: A CASE STUDY USING THE TOXIC SUBSTANCE CONTROL ACT (TSCA), Discussion Paper No. 2003-6 (2003).

is true that you cannot patent an element in its natural form as found in nature. However, if a purified form of this element is created with industrial uses—for example, [] neon—the new [forms] have a secure patent".[18]

The conclusion at first blush is that it seems as if "business as usual" characterizes the current debate about the implications of nanotechnology and the poor, rather than the old adage that learning from past experience prevents future mistakes.

The moral of the story is that the choice of a technology is not a neutral process. Choosing a technology depends on political and economic forces. It is not necessarily true that the technology which best meets our needs will be the one to survive.

III. WITHOUT A VOICE? THE POOR AND INCLUSION IN THE DEBATE ON NANOTECHNOLOGY

Salamanca-Buentello and his colleagues also presuppose that interviewing thirty-eight scientists from developing countries and twenty-five from developed countries permits them to speak of the interests of the developing countries as if they were, in fact, spokespeople for those within developing countries. In a prior article,[19] three of the same authors maintained that the position adopted by Prince Charles[20] (arguing that nanotechnology will widen the gap between rich and poor countries) and by the ETC Group[21] (requesting for a moratorium on public funding for nanotechnology) "ignores the voices of the people in developing countries."[22] Surely, Salamanca-Buentello and his colleagues intended to give voice to the people of developing countries on the issue of nanotechnology by conducting research interviews with nanotechnology scientists from the developed and developing world. Their genuine concern for those in the developing world is certainly not doubted here. Unfortunately, the opinion of scientists involved in nanotechnology does not necessarily fall within with the most appropriate of pathways for satisfying the needs of the poor. The relationship between scientists and socio-political pressures are replete with examples of doubtful practices. In the biomedical arena, for example, we can find cases of independent determination of standards in biomedical trials compromised or auto-censored by the influence of pharmaceutical corporations;[23] and there are examples of funds given by pharmaceutical corporations to universities in order to have influence on decisions pertaining to research and development ("R&D") and to gain the right for subsequent licenses. Even still, there are examples of pharmaceutical companies' bankrolling academic studies that downplay their interests.[24] Some have

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18 Lila Feisee, *Anything Under The Sun Made By Man*. Director of Governmental Relations and Intellectual Property at BIO BIOTECHNOLOGY INDUSTRY ORGANIZATION. June 2, 2004. http://www.bio.org/speeches/speeches/041101.asp (last visited February 3, 2005).

19 E. Court, A.S. Daar, E. Martin, T. Acharya & P.A. Singer, *Will Prince Charles* et al *Diminish the Opportunities of Developing Countries in Nanotechnology?*, NANOTECHWEB.ORG, Jan. 28, 2004, at http://nanotechweb.org/articles/society/3/1/1/1 (last visited June 4, 2005).

20 *See* Geoffrey Lean, *One Will Not Be Silenced: Charles Rides into Battle to Fight a New Campaign*, INDEPENDENT, July 11, 2004, *available at* http://news.independent.co.uk/uk/this_britain/story.jsp?story=540022 (last visited June 4, 2005) (explaining the position of Prince Charles on nanotechnology).

21 ETC GROUP, THE BIG DOWN (2003), *available at* http://www.etcgroup.org/documents/TheBigDown.pdf (last visited June 4, 2005).

22 Court et al., *supra* note 17.

23 Annabel Ferriman, *WHO Accused of Stifling Debate about Infant Feeding*, 320 BRITISH MED. J. 1362 (2000), *available at* http://bmj.bmjjournals.com/cgi/content/full/320/7246/1362?ijkey=334d739b3ac3456846aa637addf43d5bad31bbf0&keytype2=tf_ipsecsha (last visited June 7, 2005); *see also* Richard Woodman, *Open Letter Disputes WHO Hypertension Guidelines*, 318 BRITISH MED. J. 893 (1999), *available at* http://bmj.bmjjournals.com/cgi/content/full/318/7188/893/b (last visited June 7, 2005).

24 Richard Smith, *Medical Journals are an Extension of the Marketing Arm of Pharmaceutical Companies*, 2 PLOS MED. E138 (2005), *available at* http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0020138 (last visited June 7, 2005); J. Montaner, M. O'Shaughnessy & M.

made claims of fraudulent or doubtful laboratory trials conducted by some large pharmaceutical companies.[25] Still others describe the pharmaceutical corporations' inciting physicians to use governmental forms fraudulently in order to obtain reimbursements for medicine obtained for free from pharmaceutical companies.[26] Pharmaceutical corporations have also been accused of putting pressure on researchers to impede the flow of detrimental information into public forums.[27] And the list can go on and on. Academic opinions, therefore, can hardly be said to represent completely the voices of the poor.[28]

Technology is simply a part of a puzzle. Scholars may concur, for example, that infectious diseases constitute one of the main problems that the developing world is facing, but they may differ radically on how a solution to this problem should be attained. Prevention is not the equivalent of a cure. Nanotechnology is not necessary to reduce malaria radically, for example, as is suggested by Salamanca-Buentello and colleagues. There is no doubt that nanosensors could help to clean water, nor that nanocapsules could make drugs more efficient. Nevertheless, in the Hunan Province of China, malaria was reduced by 99% between 1965 and 1990 as a result of social mobilization backed up by fumigation, the use mosquito nets and traditional medicine.[29] Vietnam reduced the number of malaria-related deaths by 97% between 1992 and 1997 with similar mechanisms.[30] The moral of this story is twofold: (1) scientists are not always the best spokespeople of poor people, even when they come from poor countries; and (2) there are many means to an end; and technology is not always the solution. Organizing people—which some refer to as *social technology*—can be just as important. In this way, identifying potentially useful scientific technologies for the developing world must become part of a much larger and inclusive social technology if gains are to be actualized in poorer countries.

IV. OPENING THE DEBATE AND PLACING NANOTECHNOLOGY IN ITS SOCIAL CONTEXT

The history of science and technology is full of examples of technologies that have not always helped the poor. In order to serve the needs of the poor, technology has to be used in a favorable socio-economic context. Furthermore, the building characteristics of the technology, and the technological path, usually impede it from being freely used for the benefit of the majorities in developing countries.[31]

Schechter, *Industry-Sponsored Clinical Research: A Double-Edged Sword*, 358 LANCET 1893 (2001); Eyal Press & Jennifer Washburn, *The Kept University*, 285 ATLANTIC MONTHLY 39 (2000).

[25] S. Shah, *Globalization of Clinical Research by the Pharmaceutical Industry*, 33 INT'L J. OF HEALTH SERVS. 29 (2003); T. Bodenheimer, *Uneasy Alliance—Clinical Investigations and the Pharmaceutical Industry*, 342 NEW ENG. J. MED 1539 (2000); CAMPAIGN AGAINST FRAUDULENT MED. RES. ("CAFMR"), THE PHARMACEUTICAL DRUG RACKET—PART ONE (1995), *available at* http://www.pnc.com.au/~cafmr/online/medical/drug1a.html (last visited June 7, 2005); CAFMR, THE PHARMACEUTICAL DRUG RACKET—PART TWO (1995), *available at* http://www.pnc.com.au/~cafmr/online/research/drug2a.html (last visited June 7, 2005); JOHN BRAITHWAITE, CORPORATE CRIME IN THE PHARMACEUTICAL INDUSTRY (1984).

[26] Scott Hensley, *Pharmacia Nears Generics Deal on AIDS Drug for Poor Nations*, WALL ST. J., Jan. 24, 2003, at A1.

[27] J. Collier & I. Ilheanacho, *The Pharmaceutical Industry as an Informant*, 360 LANCET 1405 (2002).

[28] This argument is not meant to dogmatically equate academicians or scientists with pharmaceutical companies. Rather, it is meant to expose the deep and entrenched connections between pharmaceutical corporations and scientific/academic research to illustrate potentially how a new technology or medical application can be manipulated to prevent poorer nations from mechanically applying a useful technology to a problem which is identified by scientists/academicians, even if they come from poorer countries.

[29] Sukhan Jackson, Adrian C. Sleigh and Xi-Li Liu, *Economics of malaria control in China: cost performance and effectiveness of Henan's consolidation programme*. WORLD HEALTH ORGANIZATION, SOCIAL, ECONOMIC AND BEHAVIOURAL RESEARCH. REPORT SERIES NO. 1, 2002. http://www.who.int/tdr/publications/publications/sebrep1.htm (last visited February 4, 2003).

[30] WHO, *Vietnam Reduces Mlaria Death Toll by 97% within Five Years*, 2002, at http://www.who.int/inf-new/mala1.htm (last visited June 7, 2005).

[31] D. Sarewitz et al., *supra* note 9.

Despite the optimistic assessments recently offered, experience suggests that nanotechnology could follow the mainstream economic trends that increase inequality. First, the development of nanotechnology faces many of the same problems faced by prior technological developments because large multinational corporations are patenting the majority of the nanotechnology products. Patents are monopolistic guarantees of earnings for twenty years—something that certainly works against the rapid diffusion of the beneficial potentials of this technology for the poor.[32]

Second, nanotechnology's novel solutions and potentially laudable achievements may never come to fruition in developing countries because the main problem for a developing country is not so much the fixed costs of a laboratory of average sophistication, but the social context that is necessary for really incorporating nanotechnologies into the economy. Without fluid mechanisms of vertical integration between the sectors that produce nanoparticles and the companies that are potential buyers, the nanoparticles will never get out of the laboratory. From many accounts, this seems to be happening, nowadays, in developed countries. Wildson affirms, based on his conducting interviews at English companies that produce nanoparticles, that "nanoparticles are a solution in search of a problem."[33] Despite their numerous potential applications, the English producers say that they have a shortage of clients. This is confirmed by the cover story in a recent edition of *Business Week*, which, based on information from Lux Research, tells us that despite a promising future, many companies that sell nanotechnology products faced financial difficulties in 2004.[34] The linkages between the science and technology system and the productive sectors are very tenuous in most of the developing countries.

Third, nanotechnology's development in much of the world will do little to help the developing world due to the difficulty in finding qualified workers. A country's ability to foster and support technological careers requires a social context that supplies the necessary equipment and human capital in the long term. It will be difficult for many Third World countries to find the staff necessary to work inter-disciplinarily in nanotechnology. Mexico, for instance, the thirteenth largest exporting power in the world, only has eleven research teams in three universities and two research centers in nanotechnology, with a total of ninety researchers and no official support program for field research.[35] Brazil, which launched a pioneer program for research and development in nanotechnology in Latin America—considering that it was in the same year as the U.S. initiative (2000)—had between fifty and one hundred researchers in 2002 and probably around 300 in 2004.[36] Despite these seemingly impressive numbers in Brazil, challenging barriers remain which will continue to plague the ability of nanotechnology scientists in developing countries to produce benefits for the poor. Many nanotechnologists in developing countries may be driven by higher wages out of poorer countries and into richer ones. The reason that this potentiality must be addressed now is as follows. Some estimate that nanotechnology will mean restructuring all learning to break down the traditional disciplinary frontiers, which, in practice, nanotechnology has already overcome. It is possible that changes in study plans would have to take place starting at primary education.[37] This means that multi-sector efforts are gambled on these changes, and

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32 Corporate intellectual property ("IP") departments, which have increasingly sought to turn patents into major revenue streams, are stoking the trend. According to data compiled by the National Science Foundation, IBM won the most nanotech-related patents in 2003. Also among the top ten: computer-memory giant, Micron Technology Inc. of Boise, Idaho; manufacturer, 3M Corp. of St. Paul, Minnesota; the University of California; and Japan's Canon Inc. *See* Regalado, *supra* note 11, at A1.

33 James Wildson, *The Politics of Small Things: Nanotechnology, Risk, and Uncertainty*, 23 IEEE TECH. & SOC'Y MAGAZINE 16 (2004).

34 Baker & Aston, *supra* note 2. ("A 2004 study by Lux Research found that many of the 200 global suppliers of basic nanomaterials failed to deliver what they promised.").

35 Ineke Malsch & Volker Lieffering, *Nanotechnology in Mexico*, Nov. 5, 2004, at http://www.voyle.net/Guest%20Writers/Drs.%20Ineke%20Malsch/Malsch%202004-0001.htm (last visited June 7, 2005).

36 Laura Knapp, *Brasil Ganha Centro de Pesquisa de Nanotecnologia*, O ESTADO DE S. PAULO em linea, Jan. 20,2002, at http://busca.estadao.com.br/ciencia/noticias/2002/jan/20/138.htm (last visited June 7, 2005).

37 C.L. Alpert, *Introducing Nanotechnology to Public and School Audiences*, NANOSCIENCE & TECH. INST., at http://www.nsti.org/Nanotech2004/showabstract.html?absno=581 (last visited June 7, 2005) ("The NSF envisions a

elevated social demands are required. In many instances, poorer nations lack the resources, infrastructure and facilities for such interdisciplinary efforts as nanotechnology—particularly, where transformations must take place at so fundamental a level. Given the higher stakes and more interdisciplinary nature of nanotechnology, therefore, it is possible that the race for qualified scientists will heat up and increase the brain drain from the Third World into more advanced countries. This polarization of the labor market will punish poorer countries with less qualified labor. It is unlikely that the vast majority of developing countries will have the wherewithal, infrastructure and labor force to be able to join the nanotechnology wave and capitalize on its potentials to transform society and industry.

Finally, even if large developing countries that could join the nanotechnology wave (such as China, India, Brazil, etc.) can produce nanoproducts that could eventually result in clean and cheap energy options, in clean drinking water or in greater agricultural yields, this does not mean that the poor majority will benefit. For the poor, socio-economic structure is a much more difficult barrier than technological innovation. Nanotechnology, even where fully integrated in developing countries, does nothing to change these socio-economic structures; instead, it could serve to exacerbate existing gaps and further the technological and socio-economic isolation of the poor.

V. CONCLUSIONS

Nanotechnology is still in its early stages, but the later we choose to address their social and economic implications, the less chance there will be for the technology to help the poor because nanotechnology will put down roots within the mainstream hegemonic socioeconomic structure, characterized by worldwide inequality.

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revolution in science education from elementary school through the post-graduate level; a systemic change that recognizes the convergence of research in physics, chemistry, biology, materials science, and engineering. . .").