What we still don't know about South-North technoscientific exchange: North-centrism, scientific diffusion and the Social Studies of Science

Alexis De Greiff A.
Universidad Nacional de Colombia
Bogotá, Colombia

Mauricio Nieto O.
Universidad de los Andes
Bogotá, Colombia

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Introduction

In July of 2001 was held in Mexico City the XXI Congress of History of Science. The title of the meeting was provocative and relevant: science and cultural diversity. It was particularly significant that this already traditional gathering took place in Latin America. Mexico, cradle of some of the most complex and interesting American cultures, a vivid image of every excess of imperialism and a proud example of the survival of an autochthonous culture, seemed to be an appropriate place to discuss cultural diversity. Fifty-two different countries and hundreds of historians attended the meeting. The opening lecture was delivered in the spectacular *Palacio de Bellas Artes*, whose enormous murals conveyed a clear sense of national pride. With the aid of simultaneous translation to various languages we listened to the opening protocol interventions, all of which predicted that this was going to be a very special occasion. The special guest in charge of delivering the opening lecture was a philosopher and historian of science, Professor Roshdi Rashed. His Southern origin was congruent with the spirit of the Congress and hinted that from the outset we were taking part in a stimulating renewal. Professor Rashed highlighted the fact that "It is the first colloquium held in a country of ancient culture which is neither Mediterranean nor Asiatic" and that "It is also the first colloquium on the history of science which is not hosted by an industrial country of the North".[1]

Nevertheless, to our dismay, instead of showing the richness of the question about cultural diversity and science, Professor Rashed seemed to make an effort to close every alternative and to discourage anyone who had an interest in such a problem. Our distinguished lecturer showed his concern about the diversity, "not to say dispersion," of the discipline and his fear about the "flourishing temptation to extend social history to

[1] Roshdi Rashed, "History of Science and Diversity at the Beginning of the 21st Century" (paper presented at the Science and Cultural Diversity, Mexico City, 2003), 15.

the conceptual tradition..."[2] Throughout his whole presentation, he clearly stated what he conceived was history of science's true path by calling for an internal history of ideas. According to Professor Rashed, it was not only important to establish the difference between external social elements and genuinely scientific ones, it was also necessary "to ask ourselves what distinguishes it [science] from all other production of cultural works."[3] For Professor Rashed the diffusion of knowledge is different from its production. He goes even further when he tells us that external factors "may explain controversies when the facts are imperfectly established and proofs not rigorously carried out".[4]

We began this chapter with this episode because it seemed to us illustrative of the kind of obstacles social studies of South-North technoscientific exchange has to face. Some of the claims made in the opening lecture were not only discouraging to start a debate on science and cultural diversity but also constitute fundamental issues for the understanding of science and technology as political practices. Interestingly, Professor Rashed was right about one thing: social studies of science, far from being a fully constituted discipline, are a field that still needs to be shaped and developed. Indeed, almost a century after Ludwig Fleck published his celebrated book and after Thomas Kuhn started a new phase in the historical studies of science and technology; decades after various historians, sociologists and philosophers showed once and again – making use of case studies– the historic and social roots of epistemological problems; when the writings of David Bloor, Steve Shapin, Michel Callon, Bruno Latour, amongst others, seem to be necessary readings for historians of science; now, after all this, we can say that the social studies of science still have a long road before them and, possibly, the most interesting parts of the journey still lie ahead.

A history of the social studies of science is still missing. Their origins can be traced to a time of public and political concern about imperial and colonial interests, gender, race, the consequences of military technology, the Cold War, and our environment. The ideological linings lie on Marxism and the counter-culture movement. We should recall Paul Forman in the United States, Hillary and Steven Rose in the United Kingdom and Marcello Cini in Italy. For several future science, technology and society scholars the "Society for Social Responsibility in Science" and the "Science for the People," became spaces for political action and theoretical reflection about the role of science in contemporary society, especially in the Vietnam War. The heir of J.D. Bernal's political commitment was apparent. Their interest in science and technology passed through their wider concern about global politics. Their aim was to unveil the relation between capitalism, South-North asymmetrical relations and science and technology. After all, the 1968 movement was inoculated by anti-imperialism conscience. Sadly, the political and intellectual commitment with South-North exchange almost disappeared from the professional agendas of historians and sociologists of science. Books on the topic are rare; there are very few courses that address the issue; the presence scholars from the Third World are missing in most of editorial boards.

[2] Ibid, 27.
[3] Ibid, 22-23.

This paper intends to be an introduction to some of the central questions and topics in the study of South-North technoscientific exchange. Terms such as North, South, East, West and technoscience were coined as political notions after World War II.[5] Hence, South-North technoscientific exchange stands here for the international relations that entailed technoscience as a constituent part during the second half of the twentieth century. We shall argue that paying serious attention and analyzing South-North technoscientific exchange is essential to understand technoscience and society relations. Technoscience in the North does not develop independently of the South-North transactions. Furthermore, shifting our attention to these issues stands at the very roots of social studies of science.

This essay is an invitation to study the kind of problems, gaps, conceptual difficulties and political issues related to South-North science and technology studies. We do not attempt to cover all the possible relevant topics, but rather to offer examples that allow us to illustrate that in order to talk about science and politics we neither need to shift levels of analysis nor to change the subject. In the first section we explore how critics to traditional colonial historiography and postcolonial studies have contributed to build a critical view of science and technology. Then we offer a brief review of three different literatures, Development, Green Revolutions and Cold War. They are not necessarily related to the actual field of Social Studies of Science, but they all constitute powerful illustrations of the unbreakable bounds between science and politics, or rather, they are good examples of science as politics.

We have chosen to review[6] in some detail these subjects because they are interesting and actually crucial fields of research, but there are many others. Science and Empire, Voyages of discovery, Natural History, Geography, Medicine, Anthropology, are, among many others, fields of historical and sociological research in which the relation between scientific practice and domination have been apparent.

We hope that the topics reviewed below help to understand the importance of some of the arguments held by recent sociology of science. Despite all the evidence, as we have pointed out, some historians still try to explain science as a human product different and independent from other cultural practices. This paper aims to illustrate that for a thorough understanding of Sout-North scientific exchange we most consider seriously the fundamental lessons of sociology, i.e., that scientific knowledge and technology are inseparable from the exercise of authority, control and domination.

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[4] Ibid, 27.

[5] The term, "Third World," which for its political origins we find more accurate, was coined by the French demographer and economic historian Alfred Sauvy in 1952 (Alfred Sauvy, "Trois Mondes, Une Planète," *L'Observateur*, 14 August 1952), and catch on after the Afro-Asian Conference in Badung in 1955. We use the terms South-North and East-West in the way they are currently used in political science. North refers to the industrialised countries, some times also called "Atlantic countries"; East to the Soviet bloc; West to the United States and Europe; and South to the "Third World."

[6] Every "review paper" is a deliberate attempt of the authors to create, consolidate or close a field of research, including and excluding subjects, authors and questions in order to set an agenda for future researches (Olga

Eurocentrism, Postcoloniality and the diffusion of Science and Technology

George Basalla's model of the diffusion of science in the three stages has been sufficiently criticized.[7] Some commentators have pointed out that Basalla´s three stages might offer an adequate theoretical framework to discuss scientific development in countries such as the United States, Russia or Japan, but that his proposals are insufficient when we attempt to explain the history of science in non-industrialized countries. We are not even certain that a situation like the one described by Basalla's third stage ever took place in less developed countries. But if it did, such "national science" does not guarantee that the scientific practices of a Third World country are truly independent from foreign control

However, it seems to us more interesting to consider the assumptions that underlie this type of diffusion model. We could summarize them in the idea of modern science as a finished product that diffused without major "distortions" from a Center – Europe. One of the main contributions of the sociology of scientific knowledge is to have removed the traditional distinction between the contexts of discovery and the contexts of justification, showing that the production and the diffusion of knowledge are simultaneous processes. If we acknowledge that the creation or the birth of what we call Western science is inseparable from its expansion, the study of its diffusion attains a fundamental meaning, which is very different from the marginal and accessory place it usually occupies.

This entails that the expansion of Western science cannot be explained in epistemological terms or by the rigor of its methods; on the contrary, its status is a consequence of its expansion. The criticism to a notion of a unique and superior Western science has also been conducted by intellectual traditions different from the social studies of science and technology. For postcolonial and gender studies are useful to examine the assumptions of a historiography that has centered its attention on Europe first, and the United States later. In contrast, the historiography of technology still centers on innovation, rather than in the uses,[8] imposing serious limitations to the attempts to escape North-centrism.

Postcolonial historiography, which overlaps several questions raised by feminists, challenges the assumption that European expansion must be explained by the intrinsic superiority of such civilization. Western culture became meaningful as an identity marker when it confronted other cultures. Postcolonial studies have awaken interest in the explanation of the causal relationships between European expansion and the creation of modern science in Europe, drawing especial attention to the notion of development. The expansion of scientific practices not always had positive effects in the "peripheries." The "civilizatory" process has been repeatedly pointed out as a source of emancipation, being described as a cause of political

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Restrepo Forero, "On Writing Review Articles and Constructing Fields of Study" (Ph.D. dissertation, University of York, 2003)).

[7] George Basalla, "The Spread of Western Science," *Science* 156 (1967); A Lafuente, A. Elena, and M. Ortega, eds., *Mundialización De La Ciencia Y La Cultura Nacional* (Madrid: Doce Calles, 1993)

revolutions. The local cultural traditions are depicted as opposing themselves to development and as obstacles to progress. Conversely, it has been argued that the diffusion of scientific practices as geography, natural history or medicine have been powerful mechanisms for establishing order and efficient ways of control and domination.[9] Such processes are also important inasmuch the idea of the unity of Western science entails the elimination of other ways of knowing. The critical examination of the processes of scientific diffusion opens a whole field for historical and political meditation in a constellation of issues formerly ignored by colonial historians devoted to legal, economic and cultural aspects but oblivious to science. In this sense, Sandra Harding points out ways in which post-colonial studies of science and technology, a field that in fact still does not exist, might be conducted: "the relationship between scientific and technological change and projects of European-American empire, anti-Eurocentric accounts of other cultures' scientific and technological traditions, and the implications of the now obvious failures of the North's attempts to increase the standard of living in the South – the failure of 'development'."[10] Western science also has contributed to deteriorate 'others', namely women, ethnic minorities, nature, and Third World citizens.[11] The implantation of Western technoscience may also contribute to deprive the natives from control over their own resources, taking away power from them.

Power is exercised through concrete social practices such as natural history, taxonomy, the manufacturing of maps, sky and marine charts, searching for the cure to malaria or building a nuclear plant. These practices constitute an active exercise of power and their dissemination must be seen as an attempt to gaining control upon new spaces. Our task –as Macleod suggests– is to study science not within imperial history but as imperial history.[12]

Finally, there is an important group of scholars who, following the post-colonial movement, argue that the Third World can offer positive substitutes to Western science. By examining these ways of knowledge (which they refuse to call "alternative"), they explore the possibilities of indigenous sciences.[13] The study of local knowledge may provide elements for a dialogue between the 'experts in development' and the communities 'to be developed,' promoting cultural diversity.

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[8] David Edgerton, "From innovation to use: Ten Eclectic Theses on the Historiography of Technology", *History and Technology* 16, N.2 (1999), 111-136.
[9] For instance, Mauricio Nieto, *Remedios para el Imperio: historia natural y la apropiación del Nuevo Mundo* (Bogotá: ICANH, 2001).
[10] Sandra Harding, *Is Science Multicultural? Poscolonialisms, Femunisms and Epistemologies.* (Indianapolis, Indiana University Press, 1998), 25.
[11] Sandra Harding, *Whose Science? Whose Knowledge?: Thinking for Women's Lives* (Milton Keynes: Open University Press., 1991).
[12] Roy Macleod, "On visiting the moving metropolis: Reflexions on the architecture of imperial science". In: Nathan Reingold and Marc Rothemberg (Eds.) *Scientific colonialism: a cross-cultural comparison*. (Washington: Smithsonian Institution Press, 1987).
[13] See for instance, Ziauddin Sardar, *The Revenge of Athena. Science, Exploitation and the Third World* (London and New York: Mansell Publishing Limited), Part Three.

At this point, it seems necessary to make a few clarifications. The attempt to escape Eurocentric and Americano-centric accounts of history and the need to make other voices visible, perceptible, cannot be reduced to deny the importance of Europe or the United States in modern history, or to neglect the central role of Western science. Instead, we must explain historically, socially, culturally and politically its success and the consequences of such success. Also, the idea is not just to abandon our interest on Western science in order to rescue local knowledge. As Arif Dirlik has pointed out, "The distinguishing feature of Eurocentrism is not its exclusiveness, which is common to all ethnocentrisms, but rather the reverse: its inclusiveness"[14] Eurocentrism is not the result of ignoring others, but rather the consequence of organizing the knowledge of the world, including other ways of knowing into one single systematic whole. We must help to deconstruct this state of affairs. The temptation to identify ourselves with the excluded and to become the spokesmen of the subordinates brings about the high risk of presupposing that we are privileged and legitimate translators and spokesmen of the "other" and, therefore, of ratifying Western culture as the fundamental culture.[15]

The Race for Third World hearts and minds: the seduction of development

During the 1950s and 1960s, large portions of the world's population strove to build a national identity within the context of international tension, national class struggles, and ideological debate. Although the state of revolt is a better-known face of the Third World, it is just one aspect of these nations' history. As Arturo Escobar and others point out, this period was marked by the construction of the "development discourse" as a new form of domination over the new nations and, more generally, over the so called "developing countries."[16] International institutions, notably the World Bank and the United Nations technical agencies, played a central role in nurturing the discourse and practice of development programs. The effect of these programs has meant the creation of ever-greater gaps between rich and poor countries, the widening of the internal social, cultural and economic contrasts, the depravation of the environment and so forth. The workings of public rhetoric and practice of development are still largely unexplored in current historiography, although some efforts have been made to investigate the phenomenon in studies of discrimination through literary analysis, and anthropological works on modernization and resistance, especially in Asia and Africa, and Latin America.[17] Curiously, not even these works have tackled the issue of science and development to the extent that some historians have studied the close link between colonial domination, science and technology. An important lesson to learn from these works is the necessity of shifting the object of study

[14] Arif Dirlik, "History without a Center? Reflexions on Eurocentrism" In *Across Cultural Borders: historiography in global perspective,* ed. Eckhardt Fuchs and Benedikt Stuchtey (Lanham MD: Rowman and Lttlefield, 2002).
[15] Gayatri Chakravorty Spivak, "Can the Subaltern Speak?" In *Colonial discourse and poscolonial theory: A Reader,* ed. Patrick Williams and Laura Chrisman (New York: Columbia University Press, 1994).
[16] Arturo Escobar, *Encountering Development: The Making and Unmaking of the Third World* (Princeton: Priceton University Press, 1995).
[17] V.Y. Mubimbe, *The Invetion of Africa* (Bloomington: Indiana University Press, 1988); Chandra Mohanty, Ann Russo, and Lourdes Torres, eds., *Third World Women and the Politics of Feminism* (Bloomington:

"from the people to be 'developed' to the institutional apparatus that is doing the 'developing'."[18] In other words, we need to abandon the idea that development and modernity are "unfinished" projects everywhere but in Western Europe and North America due to the cultural and/or structural obstacles of the peoples to be "developed", and start looking at the institutions for development as instruments of control and domination and realize that scientific programs are political programs.

While Escobar focuses on development as a practice, that is the establishment and operation of institutions concerned with the implementation of programs, mobilization of resources, and creation of new spaces of representation based on the idea of "development", from a slightly different perspective, Gilbert Rist analyses the history of the concept and how it shaped the views of world history during the twentieth century. He points out that "development" is a central element of the religion of modernity. It is therefore a set of beliefs deeply rooted in our conception of social, political and economic relations in both national and international arenas. Development is a collective certainty, a dogmatic truth that is not debatable and, therefore, becomes a coercive force. "The action determined by the belief is obligatory, and does not rest upon any choice."[19] In the name of development mistakes are made and people are aware of them. In this sense the parallel with religion helps to understand the phenomenon. Religious believers realize the deep contradictions between the doctrine prescribed in the holy books and the practice of ecclesiastical institutions. However, they are tolerant. Thus, Rist defines "development" as "a belief and a series of practices which form a singly whole in spite of contradictions between them."[20]

What is the role science and technology in development theories? As John Agnew's points out all theories of development and social change contained within them positions on the role and impact of science and technology on development.[21] Surprisingly, the dialogue between science and technology studies and critical analyses of development is poor. For instance, Escobar is concerned with the negative impact caused by producing technology in one place to be "applied" in another. He thus advocates for "a policy of technological research and development in support of autonomous peasant production system".[22] According to Escobar the only way to tackle effectively the problem of poverty through useful knowledge is with peasants self-understanding, and then proceed to build a system of communication involving peasants, institutions and researchers.

Indiana University Press, 1991); Homi Bhabha, *The Location of Culture* (London; New York: Routledge, 1994).

[18] Escobar, *Encountering Development*, 107.

[19] Gilbert Rist, *The History of Development. From Western Origins to Global Faith*, trans. Patrick Camiller (London, New York, Cape Town: ZED Books, University of Cape Town Press, 1999), 22.

[20] Ibid, 24.

[21] John Agnew, "Technology Transfer and Theories of Development", *Journal of Asian and African Studies* 17, 16-31.

[22] Escobar, *Encountering Development*, 151.

This is an all too familiar prescription to science and technology historians and sociologists, who have insisted that science and technology are essentially local practices. While science and technology studies have been virtually oblivious to South-North exchange for development, critical authors to development continue treating science and technology as black boxes. Rist, for instance, explains that: "Belief is so made to tolerate contradictions – especially as, unlike scientific theories, it cannot be refuted. This is why science changes faster than belief, which has immunity against anything that might place it in question."[23] This pre-Kuhnian view of science contrasts with empirical studies that show scientists as conservative professionals, committed to their local research traditions. One should ask about the articulation between faith in development and faith in certain scientific theories and technical innovations. Indeed, Escobar has observed that science and technology act not just as "promises" (a word that reminds Kuhn's paradigm) but "makers of civilization", but in what way? Adas' work on the way science and technology as ideological instruments to establish colonial power ends in the Great War.[24] However, the role of science and technology in international relations has intensified since then. After World War Two, international development programs translated into technical assistance and scientific manpower building. How new forms of domination (development discourse) worked back-to-back with science and technology is a subject that needs further exploration. While the workings of social scientists in the diagnoses and construction of social representations of the "developing" world is studied in detail, natural scientists are missing actors in most works. Several questions require study, for instance: the role of technical personnel, engineers, scientific administrators and scientists in scientific and technological projects for development; their local negotiations and the use of local cultural resources to gain epistemological supremacy and, thus, access to resources; the image of science and technology that these agents tried to establish; the hybrid image that resulted from that effort and local knowledge.

There is an interesting asymmetry in the literature on technoscientific international relations. Whereas the works concerned with international relations between industrialized countries talk of "scientific exchange," the literature on South-North exchange is located in the studies on "scientific and technical co-operation", namely analyses of assistance programs for development. As though scientific practices, not explicitly tied to development projects in the South, were marginal to political and scientific international relations. Such distinction between exchange and co-operation must be understood as a historical product in itself. Very little has been studied about scientific excellence in the South, to use Cueto's phrase, and horizontal exchanges with the North.[25] The available resources, professional practices, instruments and impact are radically different. However, like in development theories, this difference are often perceived as defects and manifestations that we are a step behind the "developed." Indeed, a sort of "sociology of obstacles" is still

[23] Rist, *The History of Development. From Western Origins to Global Faith* , 23.
[24] Michael Adas, *Machines as the Measure of Men. Science, Technology, and Ideologies of Western Dominance* (Ithaca and London: Cornell University Press, 1989).
[25] Marcos Cueto, *Excelencia Científica En La Periferia. Actividades Científicas E Investigación Biomédica En El Perú, 1890-1950* (Lima: Grade-Concytec., 1989).

common in works on science, technology and economic development. In his seminal book *The Social Function of Science*, J.D. Bernal stressed the *constraints* imposed by local cultures in Latin America, India, and the Islamic World.[26] C.P. Snow argued called for sending an army of scientists and linguists to prevent the Third World to fall in communist hands,[27] while Ziman and Moravcisk assumed and concluded that Paradisia, an imaginary country in the South, will never progress unless the Western model of science, technology and its institutions are effectively transferred. [28]

There are, nonetheless, pockets of critical reflection that deserve attention. Critical voices, especially post-colonial studies, are heirs of the *dependency* theory. The process of institutionalization and professionalization of science in Latin America preceded and was instrumental in the establishment of national scientific policies in the 1960s (and 1950s in the case of Argentina and Brazil).[29] Sociological and economic studies stimulated by the *dependency* theorists provided thoughtful analyses of the problems of science and technology in peripheral countries.[30] Geologist Amilcar Herrera, in his influential book *Ciencia y Política en América Latina*, developed a socio-historical analysis of scientific research of Latin America. He criticized the contradiction between what he called the "explicit" and the "implicit" science policies operating in the South. The former, the rhetoric of science for development, was the façade covering the local elite's lack of commitment to national development, a disinterest that characterized the implicit policy.[31] The *dependency* theory, which can be placed among the "dissident voices" of development, led to a debate that was particularly fruitful in Latin America.[32] The central thesis was that "underdevelopment" in the periphery was inseparable from capitalist development in the metropolis, where the metropolis referred to the Western imperialist (and, after decolonization, Neo-imperialist) powers and the periphery to the colonies (and the Third World). In their view, local elites acted as agents of neo-colonialism and underdevelopment. Third World economic and cultural dependency and social crisis was due to collusion between external actors, the colonial powers, and internal ones, the local élites, and by extension, scientific and technological development in peripheral economies was severely limited by external interests defended by the local elite.[33]

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[26] J.D. Bernal, *The Social Function of Science* (Cambridge, MA: The MIT Press., 1964 [1939]).
[27] Snow, *The Two Cultures*, 48.
[28] Michael Moravcsik and J.M. Ziman, "Paradisia and Dominatia: Science and the Developing World", *Minerva* 53, N. 4, July 1975, 699-724.
[29] Thomas Glick, "Science in Twentieth-Century Latin America," in *The Cambridge History of Latin America, Vol. 4, Ideas and Ideologies in Twentieth Century Latin America*, ed. L. Bethell (Cambridge: Cambridge University Press, 1996), 348-349.
[30] Celso Celso Furtado, *La Economía Latinoamericana* (Mexico City: Siglo XXI., 1976)).
[31] Amilcar Herrera, *Ciencia Y Política En América Latina* (Mexico City: Siglo XXI Eds., 1971).
[32] F. Cardoso and E. Faletto, *Dependency and Development in Latin America*, trans. M. Urquidi (Berkeley: University of California Press., 1979). The school has roots in the United States (Paul Baran, Paul Sweezy), in Chile (Oswaldo Sunkel), in Brazil (Cardoso, Faletto and Celso Furtado), in Colombia (Orlando Fals Borda), and in Mexico (Rodolfo Stavenhagen).
[33]Hebe Vessuri, "The Social Study of Science in Latin America," *Social Studies of Science* 17 (1987); Glick, "Science in Twentieth-Century Latin America," , 347-355.

While these studies have been praised for stimulating a critical discussion of capitalist development at the periphery, they have equally been criticized for their "ideological" bias and lack of empirical evidence.[34] *Dependency* theorists have also been criticized for the lack of empirical studies that show in detail the dependency character of global knowledge. Sociologists of science and technology who became important science administrators, such as Francisco Sagasti, were enthusiastic supporters of the North American "systems approach", but close to *dependency* theory. Even his works "remained a largely formal, abstract, reductionisms analysis of science and technology development which was difficult to translate into action."[35] Reacting to these criticisms, the heirs of the dependency theories engaged in science studies have been investigating case studies, for instance in relation to the Green Revolution (see below).

D*ependency* theory was perhaps the most original contribution to science studies by and about Third World scientists. Several intellectuals in this region rebelled against the assertiveness of the North, and demonstrated the possibility of offering alternative solutions to the problem of the role of science in the Third World.[36] These studies marked a turning point in the history of ideas in Latin America in particular, and the Third World in general.

Dependency theory also produced a lively debate within the scientific communities, particularly on the question of the social use of "pure" science in *developing* contexts. During the 1970s, politicians and administrators, eager to cut funds for research in universities, and to close or reduce other research institutions, strategically invoked the irrelevance of pure science for Third World development. In several Third World countries, resources for research for pure science, already scarce, were radically reduced and the research that did continue was redirected towards projects with "a social utility." The industrialized countries shared this view, discouraging scientific research in the South as well as international cooperation in subjects "not directly related to development." Since the 1950s science has been considered a luxury that Third World nations cannot afford. For instance, the negotiations to create an international centre for the promotion of theoretical physics in the Third World met an open hostility from delegations of virtually all industrialized countries.[37] Nonetheless, it is worth insisting that in spite of such attitudes, and the concomitant difficulties due to the lack of resources, non-applied research is carried out in Third World countries. Yet, the bulk of the literature is concerned with technology transfer, while science is seldom mentioned.[38]

In the discussion above we referred to scientific institutions. National research centers in the Third World developed interesting and complex intellectual, political, technical and economic links with institutions

[34] See Dudley Dudley Seers, *Dependency Theory : A Critical Reassessment* (London: Pinter, 1981).
[35] Hebe Vessuri, "The Social Study of Science in Latin America."
[36] Terry Shinn et al., "Science, Technology and Society Studies," 11.
[37] Alexis De Greiff, "The tale of two peripheries: The creation of the International Centre for Theoretical Physics in Trieste", *Historical Studies in the Physical and Biological Sciences* 33, Part 1 (2002), 33-60.
[38] See Wesley Shrum, Carl L. Bankston III and D. Stephen Voss, *Science, technology and society in the Third World: an annotated bibliography* (Metuchen, N.J. and London: The Scarecrow Press Inc., 1995).

in the North. Although the number of works is growing,[39] we are far from having a good map of these institutions and their mutual relations. We need to learn more about the role of academies and scientific societies in the South in the consolidation of local elites who used the science for development discourse, becoming local agents of aid programs offered by the industrialized countries. Political and scientific elites in the Third World often received training in Europe and the United States. However, detailed investigations of the globalization of knowledge after the Second World War are scarce. Although it is obvious for some, we must recall that institutional histories cannot be studied independently from cognitive aspects, for they provide the resources necessary for understanding research and pedagogical practices. In particular, by scrutinizing centers that promote South-North co-operation we are able to increase the understanding of the role of scientific institutions in the construction of development programs and, concomitantly, learn about the global distribution of knowledge. Science, technology and training programs were enthusiastically supported by philanthropic foundations. Nevertheless, the existing studies show also the enormous diversity of motivations, mechanisms and strategies deployed by applicants and foundations alike. Indeed, if we really want to learn about the patterns of funding by American philanthropic foundations, and the kind of knowledge they eagerly promoted, we must focus on their activities in the Third World, where these bodies invested more than twice their total budget on institutions in Europe.[40]

At a different level, we have scientific disciplines. First, development discourses and practices produced varying images of science. The image of modern science and progress was represented by the theoretical physicist rather than by the agronomist. The diffusion of such representations, and certain practices associated to them, were closely related to the models of development and the role ascribed to technoscience. Of course, local cultures and traditions influenced such images.[41] What is the relation between such ideas about science and technology and the modernity projects in the different cultural settings in the South? Financial support was invariably conditioned to demonstrate that the projects contributed to development. Hence, some areas of research became more "pertinent" than others. Why did governments support certain scientific projects, such as theoretical physics or corrosion and what was expected from them? What did scientists do to fulfill those expectations or at least give that impression? Analyses of the different "discursive strategies" employed by scientists in their countries and abroad would through light upon the problem of the establishment of scientific disciplines in specific cultural environments, showing that development was, like technoscience, essentially a cultural phenomenon. Finally, one must ask whether development requirements shaped research and how. Some areas of research, in both scientific and industrial settings, that came from the

[39] Dong-Won Kim, "The conflict between image and role of physics in South Korea", *Historical Studies in the Physical and Biological Sciences* 33, Part 1 (2002), 107-130; Ana Maria Ribeiro de Andrade, *Físicos, mésons e política. A dinamica da ciencia na* sociedade (Sao Paulo and Rio de Janeiro: Editora HUCITEC; Museu de Astronomia e Ciencias Afins, 1999).

[40] Alexis De Greiff, "Supporting Theoretical Physics for the Third World Development. The Ford Foundation and the International Centre for Theoretical Physics in Trieste (1966-1973)," in *American Foundations and Large-Scale Research: Construction and Transfer of Knowledge*, ed. Giuliana Gemelli (Bologna: CLUEB, 2001), 25-50.

North had to be adapted in the South for cultural traditions, infrastructural facilities, human and natural resources, etc. were different. These processes of adaptation are in effect "new uses" of material and conceptual artifacts. The study of such uses may open a very different picture of innovation in the South.[42]

The old and new Green "Revolutions"

Food and poverty, and since the 1970s environment, have been the central issues of most development programs. The Green Revolution is perhaps one of the most discussed cases in the literature on science and development. As an environmental historian explains, it was "a technical and managerial package exported from the First World to the Third beginning in the 1940s but making its major impact in the 1960s and 1970s."[43] In 1970, the American botanist Norman Borlaug, Director of the Division for Wheat Cultivation at the *Centro Internacional del Mejoramiento de Maíz y Trigo* in Mexico, was awarded the Nobel Peace Prize. He was the main promoter of a worldwide agriculture development program, based on the genetic manipulation of seeds to improve production – the Green Revolution. The program was introduced in several Asian countries in 1965. Five years later, the program covered 10 million hectares of cultivated area. The program was promoted and supported by several institutions from the United States, France, Canada, Germany, Brazil, India, Nigeria and others that constituted the Consultative Group of International Agricultural Research. Philanthropic foundations, such as the Rockefeller and the Ford participated with decisively in the program.

The impact of the Green Revolution is the source of major debates. On the one hand, the effects on national production of wheat and rice became apparent. A number of countries in South America and Asia achieved record harvests. By the end of the 1970s, India became self-sufficient in wheat and rice, tripling its wheat production between 1961 and 1980. This is the positive side of the Green Revolution, according to its apologists.[44] On the other hand, since the1970s the Green Revolution has been subjected to severe criticisms. The main one was that, for the program to be profitable, it was necessary rich soils, optimal irrigation, intensive use of fertilizers and chemical pesticides. In addition, by the early 1980s, environmentalists found that intensive fertilization stimulated by the Green Revolution led to euthrophication of rivers and lakes. Although some countries increased their agricultural productions, other regions, with little water and lack of credit markets such the sub-Saharan, suffered. Even in those countries where it was successful, some authors found flaws. J.K. Bajaj argues that, rather than improving the agricultural system, it devastated its productivity and increased hunger. Economic dependence increased, for the cereals import reduction was

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[41] Kim, "The conflict between image and role of physics in South Korea."
[42] We are following Jorge Katz's *De la importación de tecnología al desarrollo local* (Mexico: Fondo de Cultura Económica, 1976), and David Edgerton, "From innovation to use."
[43] John McNeill, *Something New under the Sun. An Environmental History of the Twentieth Century* (London: The Penguin Press, 2000), 219.
[44] Ibid, 219-227; Bernhard Glaeser (ed.) *The Green Revolution revisited. Critique and alternatives* (London: Allen & Unwin, 1987), 1-9.

compensated by imports of fertilizers and knowledge dependence on "experts". Thus Bajaj questions the assertion that the Green Revolution made India self-reliant in agricultural production.[45] From the environmental point of view, the speed and scale of dissemination of new breeds made the Green Revolution the largest set of crop transfer in world history, reducing dramatically biodiversity.[46] Socially, the Green Revolution widened the gap, favoring large landholders who had access to Western education. The drop in the prices of wheat displaced small farmers, who led to the development of urban slums.

The studies about the political dimension of the Green Revolution reveal important features of the twentieth-century tensions. It created the promised land of an export-oriented efficient agriculture, which in turn would lead to rapid industrialization, the key of development, according to the economic theories of the day. The Green Revolution was the epitome of a technoscientific solution, alternative to a social revolution. In regions close to the communist border, such as Turkey and Korea, its introduction was a result of the American fear to the spread of Chinese communism.[47] However, the quit of this revolution was presenting itself as apolitical. Analysts such as Edmund Oasa, who was commissioned by the Consultative Group to make an evaluation of the program, concluded that class lines and conflicts worsened as a result of the "inherent contradictions in CG [Consultative Group] policies and the *politically neutral stance that the Group has adopted*, at least superficially."[48] Promoters of the Green Revolution assumed that a technical solution could solve deep social problems, such as land distribution and the exploitation of the work force. The Group isolated itself from political debates, instead of incorporating them as a crucial element of the problem. Vandana Shiva's argument is even more radical. Punjab, in the limit between Pakistan and India, was supposedly the Green Revolution's major success. However, the socio-economic conditions of this region are deplorable, and violence continues to be endemic. This tragedy is presented as an endogenous situation, caused by ethnic conflict between religious groups, and therefore independent of the Green Revolution. Shiva offers an alternative interpretation; "it traces aspects of the conflicts and violence in contemporary Punjab to the ecological and political demands of the Green Revolution as a scientific experiment in development and agricultural transformation". Moreover, Shiva brilliantly demonstrates how science "was offered as a 'miracle' recipe for prosperity. But when discontent and new scarcities emerged, science was delinked from economic processes."[49] Such power of science to vanish from the political scene when things go wrong cements the faith in technoscience as the engine of progress. It erases the contradictions between theory and practice of development. More case studies on South-North exchange programs will be helpful to understand issues on science and democracy today.

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[45] J.K. Bajaj, "Science and Hunger. A Historical Perspective on the Green Revolution" in Ziauddin Sardar, *The Revenge of Athena. Science, Exploitation and the Third World* (London and New York: Mansell Publishing Limited), 131-156.
[46] McNeill, *Something New under the Sun. An Environmental History of the Twentieth Century* , 224. See also Vananda Shiva, *The Violence of the Green Revolution. Third World Agriculture, Ecology and Politics* (London and New York: Zed Books Ltd, 1991), Chapter 2.
[47] McNeill, *Something New under the Sun. An Environmental History of the Twentieth Century* , 222.
[48] Glaeser, *The Green Revolution revisited*, 3.

Genetic engineering (GE) and its products, Genetic Modified Objects (GMOs) is seen as the new technological promise to alleviate hunger in the Third World. Furthermore, this technology involves not only transfer of plants, knowledge, techniques and processes from North to South. It looks for genes to manipulate and "improve." Thus, the GE firms require germplasms from regions with vast genetic resources, such as the Amazon forest. In other words, the relation is bidirectional: GMOs are moved from the North to the South, while genes are drained in the opposite direction. As far as the technology transfer to the South concerns, it has been argued that the Green Revolution has served as a point of reference to identify the issues at stake.[50] Indeed, GE cannot be understood without a deep analysis of the Green Revolution. Hitherto, the Green Revolution has been studied mainly in the Indian case. But, GE companies have interests in other Third World countries. Hence, we need to learn more about the process of inception and the impact of the Green Revolution in other parts of the world. In the Amazon region, for instance, Colombia, Peru and Ecuador are virtually unexplored. What lesson did GE firms extract from the Green Revolution is an important question. The conclusions above come from the critics, while we need to know more about those who consider it a success and, therefore, justify GE as an improved version of that first experiment. In terms of the exploitation of Third World genetic resources there are urgent questions to tackle. As we mentioned above, the appropriation of natural resources was a central element of the imperialist policies in the late the eighteenth century. What kind of technoscientific practices may or may not lead to domination relations? For instance, much analysis, discussion and debate are needed regarding access to intellectual property and patents regulations. Compared to the development years, the center of power has shifted to the private sector. What are the implications of the leading role of corporate powers, especially in those regions where the State has been endemically weak? International institutes of research that participated in the Green Revolution are engaged in genetic research in associations with partners in the North. For instance, Lawrence Surendra argues that the International Rice Research Institute in the Philippines has been instrumental in the "gene drain" from the South to the North. This trend requires serious attention, analysis and action.

Big Science and the Cold/Hot War: a South-North Perspective

The Cold War and the development ideologies, programs and discourses overlapped. Furthermore, "development" was an instrument of domination and a constitutive factor of the Cold War. In the Third World this phenomenon was particularly evident, for internationalism became a powerful ideological tool to win the people's hearts and minds. However, the final objective was not winning their hearts and minds, but the political control of geopolitically strategic territories and resources. Yet, the twentieth-century historiography of international relations sees the Cold War as an East-West confrontation, while the South-North relations are examined in terms of their economic exchanges, despite the fact that the War in the South wasn't Cold.

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[49] Vananda Shiva, *The Violence of the Green Revolution*, 20.
[50] B. Sorj and J. Wilkinson, "Biotechnologies, Multinationals and the Agrofood Systems of Developing Countries", in *From Columbus to Congra: the Globalization of Agriculture and Food*, ed. A, Bonanno, L. Busch, W.H. Fieldland, L. Gouveia, and E. Mingione (Kansas: University Press of Kansas, 1994), 85-104.

The Cold War burned entire alternative political projects (such as Allende's in Chile) and produced millions of deaths and refugees (Guatemala, Vietnam, or Congo, to mention just a few examples).

It is perhaps not surprising that the literature on scientific internationalism has focused on the first liberal globalization period (1870-1914) and the crisis generated by the Great War and the inter-war years.[51] It is more difficult to explain why the historiography of science has shown such little interest in these issues in relation to political attitudes after 1940. The rhetoric of scientific internationalism took a new and perhaps more dramatic turn after the war because of the increasing importance attributed to science and technology, catalyzed by the threat of a nuclear conflict. Hence the post-colonial period offers an excellent and under-used context in which to study the phenomenon of international science and the ideology of scientific internationalism.

Indeed, as some studies suggest, in areas such as nuclear armament and space research after 1957, the role of scientists in the formulation of foreign policy was crucial.[52] One of the most interesting aspects of the Cold War was the establishment of international scientific forums. Creating environments for scientific exchange between the superpowers was never a trivial problem either for foreign policy makers or for scientific advisors concerned with issues of national security.[53] But, what about organizations for South-North and South-South exchanges? Among the numerous questions one could ask: what was the position of different governments towards initiatives sponsored by a neutral organization such as the United Nations? What kind of political dividends or costs did they see in this kind of initiatives? To what extent those scientists who acted as advisers to international forums reflected the interests of their own delegations? As the Third World is not a monolithic unit, we will find very different stances before the creation and establishment of those organizations. The case of the International Centre for Theoretical Physics is a case in point.[54] The analysis of similar cases would allow us to investigate in detail the different conceptions of the role ascribed to science and technology as an instrument of ideological penetration.

For scholars concerned with questions on technoscience in the South, it is always disappointing how little has been studied Cold War technoscience outside the United States and Western Europe. The literature on science, technology and the Cold War concentrates on the production of knowledge and the production of technological goods and, in particular, how the Cold War "distorted" science and technology.[55] Big science

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[51] B. Schroeder-Guhedus, "Nationalism and Internationalism," in *Companion to the History of Modern Science*, ed. R.C. Olby, et al. (London: Routledge, 1990).
[52] L. Wittner, *One World or None. A History of the World Nuclear Disarmament Movement* (Stanford, CA: Stanford University Press., 1993); L. Wittner, *Resisting the Bomb. A History of the World Nuclear Disarmament Movement* (Stanford, CA: Stanford University Press., 1997)).
[53] Y. Rabkin, *Science between the Superpowers* (New York: Priority Press., 1988).
[54] De Greiff, "A tale of two peripheries."
[55] David A. Hounshell, "Epilogue. Rethinking the Cold War; Rethinking Science and Technology in the Cold War; Rethinking the Social Study of Science and Technology", *Social Studies of Science, (Special Issue: Science in the Cold War)* 31, N.2 (April 2001), 289-297.

occupies a privileged place in the social studies of science, focusing on the industrial-academic-military complex in the United States. In short, nuclear weapons, the space race and high-technology military gadgets dominate the literature. It has been argued that Big Science is a phenomenon that transcends the obvious question of scale. It affected the way in which scientists interacted with power, the public image of power, interactions between scientists, engineers, technicians and administrators and pedagogical techniques.[56] Institutions in the United States and Europe that possessed no big instruments became laboratories of theoretical physics, developing new techniques, concepts and theoretical technologies.[57]

Big Science had, in fact, a significant impact in the image and practice of science and technology in several Third World countries. The most immediate example is the nuclear programs in some Third World countries. The public's astonishment before the nuclear capability of nations such as Pakistan, Iraq or Iran is a consequence of the little attention paid to nuclear research programs that started some thirty years ago with the active assistance countries such as the United States, Canada, France and the United Kingdom. The establishment of a regional nuclear hegemony was certainly a motivation, though not the only one. In his short but sharp book Itty Abraham suggests that the Indian program was a modern fetish that served consolidating the State. The Indian project was, he argues, a strategy that must be seen in the frame of post-colonial culture. He also shows how the Indian Atomic Energy Commission was able enough to negotiate simultaneously with nuclear providers in the North in order to produce an atomic explosion *on Indian soil*.[58] Similar negotiations took place in other countries interested in building an atomic arsenal, such as Iraq and Israel. Of course, nuclear diplomacies varied enormously from country to country. However, those states engaged in building nuclear capacities, either for peaceful or other uses, such as India, Pakistan, Argentina, Brazil, Spain, Iraq and Israel, adopted an active search for new providers in the North.

Those cases have deserved attention in the last few years, but there is a universe to explore in this direction. In the mid-nineteen fifties, framed in the "Atoms for Peace" initiative, the United States started an atomic policy towards some Third World countries. The logic of this assistance followed the Cold War geopolitical interests. Atomic Energy Commissions were set up in virtually all nations, waiting for the arrival of the promised technology. The United States donated several small research reactors. Somewhat reluctantly, political elites in those countries who had showed no interested in developing nuclear capability – Colombia and Paraguay, for instance – accepted the American "gift" because of the symbolic meaning of the nuclear dream. It did not represent the development local knowledge, but an imported modernity. Thus, these nations became passive recipients of an unexpected, and perhaps useless artifact. In contrast to India or Pakistan, they did not look for other exchanges. From the American perspective, the reactor was a political instrument

[56] Peter Galison and Bruce Hevly (eds), *Big Science. The Growth of Large-Scale Research* (Stanford: Stanford University Press, 1992).
[57] David Kaiser, "Making Theory: Producing Physics and Physicists in Postwar America" (PhD dissertation, Harvard University, 2000).

to press governments to sign bilateral treaties with that government. Meanwhile, scientists, who saw it as an opportunity for the institutionalization of physics, developed the necessary skills, bringing into the debate human and non-human allies – such as the reactor itself – in order to break the skepticism.[59] Through an analysis of this complex web of interests and negotiations one could learn about the role of Third World scientists in diplomatic exchanges; the relation of science and technology and the militaries in the Third World;[60] the intertwining of Cold War science and the development ideology; industrialized countries' criteria to collaborate with certain regimes rather than others. In relation to the latter question, a comparative study would answer a crucial question: Did countries that exported nuclear technology to the Third World have a coherent policy or simply responded to the local nuclear companies' interests? Who actually benefited from programs such as "Atoms for Peace"? It has been suggested that the current view that the United States was successful in using its technology as a political instrument to prevent nuclear proliferation in the Third World is superficial. He demonstrates that the United States pumped resources to countries that never planned to develop nuclear weapons, while those engaged in such projects moved in various international circuits simultaneously. In contrast, the scientific communities without any nuclear infrastructure learned how to use the American program for their own interests.[61]

The participation of the South in Big Science projects is another unexplored issue. The reconfiguration of research in the North shaped the interests and practices of technoscience in the South, not least due to the numerous physicists trained in the North. At their return, these scientists struggled to set up research groups in order to continue their participation in big experiments. International collaborations are imbued in cultural exchanges and multiple tensions, where national stereotypes, class, ethnicity and gender play a role.[62] In other words, the dynamics of such exchanges is also driven by a power struggles. Authors like Andrew Pickering argue that the ability of groups to adapt to different contexts is constrained by theoretical, experimental and instrumental expertise as well as career strategies. His emphasis is on the microsociology of scientific research carried out in elite institutions, forgetting "marginal" players.[63] We stress that access to symbolic capital is determined by social structures. Therefore, the geo-institutional location of the different groups seems crucial to participate effectively in what he has called "opportunism in context"; epistemological contexts depend on social contexts. Peter Galison teaches us that in order to separate noise from signal – the goal of an experiment – experiments must develop great familiarity with the

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[58] Itty Abraham, *The Making of the Indian Atomic Bomb. Science, Secrecy and Postcolonial State* (London and New York, 1998).
[59] Juan Andrés León, "Los inicios del programa nuclear colombiano 1955-1965: diplomacia y ayuda internacional en la formación de una comunidad científica del Tercer Mundo durante la era del desarrollo," (Undergraduate thesis, Universidad de Los Andes (Bogotá), 2004.
[60] See Diego Hurtado de Mendoza, "Autonomy, even regional hegemony: Argentina and the 'hard way' toward the first research reactor (1945-1958)," *Science in Context* (forthcoming).
[61] León, "Los inicios del programa nuclear colombiano 1955-1965", 112-113.
[62] Sharon Traweek, *Beamtimes and Lifetimes. The World of High Energy Physicists* (Cambridge, MA: Harvard University Press, 1988).

instrument through long manipulations.[64] What is the role assigned to Third World scientists who visit the lab once a year for a few months? How is the division of labor decided, and what are the effects? The concept of "trading zone"[65] is useful if we realize that these are spaces of interactions between different scientific subcultures to coordinate different global meanings, but also spaces of cultural and political negotiation in a broader sense. And, finally, what about pedagogical regimes? It would be interesting to investigate how, when and why theoretical techniques developed in the Third World.[66]

The active role of local actors forces us to ask about other international initiatives. If we know little of the American and Soviet foreign scientific policy towards their allies, we know even less about their activities in "unfriendly" nations. For instance, the Soviet Union provided technical assistance to several countries in Latin America, apart from Cuba. It also hosted several students from nations under the American orbit who returned to their home countries after finishing their graduate studies. What was the logic behind such initiatives? What was the impact on research and pedagogical practices? How was the interaction of these scholars with those coming from the Western block? Such issues deserve special attention if we wish to learn about technoscientific international relations in a broader perspective.

Cold War science has been associated to Big Science, excluding technoscience in the Third World. Although nuclear weapons were central in the East-West negotiations, it is important to realize that the main battlefield of the Cold War was the Third World. The military actions of the second half of the twentieth century took place in Asia, Africa and Latin America. While nuclear weapons had a deterrent effect, small weapons were widely used in this period. Vietnam was a painful episode in American history. However, the number of Vietnamese civilian casualties was about sixty times the number of American deaths. Emphasis continues to be on the East-West confrontation and the implications the War had on the social, political, economic and, in a lesser degree, scientific and technological consequences in the United States, Europe and, more recently, the Soviet Union. We have to make a step forward and look at the victims of the Cold War. Development and Cold War discourses conflated the Northern neo-colonial ambitions in the South; thus, the Cold/Hot War can be seen as a phase of the South-North exchange, modulated by the East-West tension. Furthermore, if we adopt this perspective, the new century's terrorism could be seen as another phase of this conflicting relationship.

This perspective would allow us to shift our attention to other problems related to South-North exchange. Twentieth-century warfare was transformed by the innovation and new uses of the conventional weaponry and aerial technology. We should investigate the participation of scientists and engineers and their

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[63] Andrew Pickering, *Constucting Quarks: A Sociological History of Particle Physics* (Chicago: University of Chicago Press, 1984).
[64] Peter Galison, *How Experiments End* (London: Unwin Hyman, 1987).
[65] Peter Galison, *Image and Logic. A Material Culture of Microphysics* (Chicago: University of Chicago Press, 1997).

negotiations with the militaries in such endeavors. Following a liberal ideology, most historians believe that the collaboration between scientists and militaries is contingent and unfortunate.[67] This idea has permeated also Third World historiography. The rise of military dictatorships has been associated with massive scientific emigration and the destruction of scientific communities in countries such as Argentina. However, it would be naïve to think that the militaries lacked any interest in technoscience. Some countries in the South, such as Brazil, produce and export military technology, thanks, among other things, to the participation of qualified personnel whose skills, education, kind of research that carry out, relative power in the military and political structure is ignored. Knowledge transfer and adaptation to local conditions must have occurred. Such transfer, both South-North and South-South, entailed weapons, but also repression instruments that became routine anti-communist techniques like torture. The other side of the conflict needs to be investigated too. We know almost nothing about innovation and new uses of technology in the insurgent forces. We have to warn those interested in this line of research: if we focus on innovation, as historiography of technology has done, the result is likely to be deluding.[68] On the other hand, if we concentrate on the new uses of technology, there is a fertile field: the adaptation and use of gas pipes as bombs by insurgent groups in Colombia, or the bicycle in Vietnam are two examples. The question can be extended to study terrorism, as the reinvention of kamikazes in New York demonstrates.

Open remarks

We began this Chapter referring to the importance that South-North exchanges had for the generation who rethought science and society relations in the North. The "Science for the People" movement took the lead in demonstrations against the participation of scientists in the Vietnam War. However, as time went, this interest decreased. We do not know of a single study about the Jason Division or similar bodies in anti-communist wars in the South.[69] In order to understand the dynamics of these conflicts, we must learn the conception, representation and actions of those scientists who participated in governmental decisions or acted as consultants.[70] However, our research cannot be confined to the role of scientists involved in politics but also to investigate scientific practices themselves in order to make visible its political consequences. This would be an opportunity for social studies of science to rediscover and vindicate its political vocation in an age of growing gaps and dangerous confrontations between North and South.

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[66] Kaiser, "Making Theory: Producing Physics and Physicists in Postwar America."
[67] David Edgeton, "Science and War," in *Companion to the History of Modern Science*, ed. R.C. Olby, et al. (London: Routledge, 1996), 934-945.
[68] David Edgerton, "From innovation to use."
[69] The existence of the Jason Division, where young theoretical physicists participated, was exposed in The New York Times, *The Pentagon Papers* (New York: Bantam Books, 1971).
[70] Mark Solovey, "Project Camelot and the 1960s Epistemological Revolution: Rethinthing the Politics-Patronage-Social Science Nexus," *Social Studies of Science* 31, no. 2 (2001): 171-206, Special Issue edited by Mark Solovey).

We have presented what we consider could be some of the most promising and relevant lines of research in history and sociology of science. The topics and problems reviewed above cover a wide variety of fields and some of them have been approached from different literatures and perspectives, but they all share common grounds for analysis.

As it has been argued, the study of North-South scientific exchange can profit from the recent debates raised by both postcolonial historiography and by sociologists of science. Traditional dichotomies such as "Scientific/social", "technical/social", "science/technology", "external/internal", "political/epistemological", "pure/applied", "Scientific production/scientific diffusion" and "power/knowledge" prevent a thorough understanding of either science, technology or society. The idea of science and technology as autonomous enterprises, independent from politics has been one of the major obstacles for a critical explanation of the role of science in the shaping of the modern world. In particular, the study of South-North scientific exchange needs to take seriously the political character of science and technology. Our task, borrowing Macleod's expression, is to study science not within political history but to explain science as political history.

Image

Figure: The Hobo-Dyer Cylindrical Equal Area Projection of the ("inverted") Globe.

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UNAL, COLCIENCIAS, Uniandes,