DISCUSSION

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THE LATIN AMERICAN NUCLEAR DEBATE

1. Introduction

The nuclear controversy in Latin America is nearly half a century old, resulting in different ideological sets of beliefs about technology. Opposition or support to nuclear technology set in along three major themes. Actors in the national security debated nuclear energy as a defense technology[1]. Actors in the economic debate saw nuclear energy as a source of either wealth or poverty. Actors in the moral debate considered nuclear energy either evil or a gift from the gods. These themes interpenetrated with local and international factors, producing different programmes. The actors changed positions according to whether or not they belonged to the technological program. This paper presents the debates in Mexico, in Brazil, and in Argentina, including the Austrian-Argentinean cold fusion fiasco.

The press and academic literature, emphasizing the recent nuclear interactions between Brazil and Germany and on the programs in Argentina and Mexico, have overlooked the fact that these countries not only debated the possibility of nuclear programs in 1945 but actually did their best to have operational programs by the 1950's. These earlier debates marked and shaped the developments of the 1970's and beyond. The paths then started resulted in policy structures which have similarities and differences. They are similar because of the influence of the advanced industrialized countries. However, the nuclear technologies differ and depend on the political and economic linkages of each country[2].

2. Mexico: The Discontinuous Path

The initial Mexican reaction to the bombings of Hiroshima and Nagasaki was one of criticism. Mexicans compared them to the use of science in the German concentration camps, seeing both as clear evidence of the despicable state of mankind. Some declared themselves against science. In contrast, Manuel Sandoval Vallarta, a leader of the scientific community, one of the greatest Mexican scientists ever and then physics and mathematics coordinator of the Mexican National Research Council, recognized the economic and political significance of nuclear developments despite his moral concerns about nuclear proliferation. At the international level, Vallarta

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proposed a meeting of experts to discuss the impact and uses of atomic energy. At the national level, he and other prominent Mexican scientists[3] called for research so as to prepare Mexico and reduce its future technological dependency on the advanced industrialized countries, particularly the United States. They understood that Mexico had no alternative but to invest in science, in general education and in higher education. The scientists highlighted the need for advanced training for the scientific community, which the forthcoming president Miguel Alemán had promised to the nation. At the same time Mexico protected its access to strategic minerals by governmental legislation.

Immediately after the war, Mexico had the conditions to start a nuclear program. The critical attitude of Mexican scientists towards military applications of science entailed that only peaceful research activities would be possible in Mexico. A realistic position existed in the country, as represented by Luis G. Segura's opinion, that the atomic bomb was not a problem per se. Peace was impossible in a world with injustice, poverty, violation of political and religious rights, and starvation. These were -and are- political and not technical problems. The cheap energy promised by the atom could not address political issues because technology per se did not solve anything. Segura also pointed out that atomic energy added to the problem at the international level because the United States insisted on a monopoly of atomic technology - which might actually promote nuclear proliferation and maybe even war.

Despite these strong origins, today's Mexican nuclear program is characterized by discontinuities. For instance the hybrid concept of importing components from different firms but keeping project management under Mexican control resulted in serious problems with American engineering firms. Crises and reformulations followed one after the other until the Compania Federal de Electricidad took over but with foreign advisors. The latter include Ebasco Service, Inc., General Electric for the supply of the reactor and the fuel charge, and Mitsubishi for the turbine. Mexican R&D activities, including those on the fuel cycle, came to a halt.

In contrast these origins still manifest themselves in the Tlatelolco Treaty for a Latin American nuclear free zone. If eventually totally implemented, the Tlatelolco Treaty may lead to an end to military development of nuclear energy in the region. The exclusion of armaments defended in the Tlatelolco international negotiations could also have generated a common integrative Latin American nuclear technological effort. It was to be the "other side" of the ban on atomic armaments. The actual results were very different. The Tlatelolco Treaty could not solve the dilemmas created by the tensions and ties between the necessary huge civilian technology, including nuclear plants and the complex of fuel cycle industries, and the military programs. The formula of renouncing all military, and developing only the civilian applications could justify a common civilian technology, trade of atomic materials and instruments, and technology transfer. It was not to be. Argentina did not ratify the Treaty, and Brazil and Chile ratified it only conditionally. Although the treaty restricted the interactions between civilian and military applications, the national military establishments have had the final word on the subject.

3. Brazil: The State Between National and Foreign Pressures

The nuclear debate in Brazil also had nationalist, economic and moral tones. Several ideas, individuals and institutions, already present in the first few weeks after the bombings of Hiroshima and Nagasaki, continue active to this day. Tensions with the United States dominated the Brazilian nuclear development. These tensions had to do both with Brazil as a source of raw materials and with Brazilian access to nuclear technology and training.

The great majority of Brazilians disapproved of the atomic bombing of Japan. For instance, a gossip column in the 9 August 1945 issue of *O Estado de São Paulo*, one of the nation's most important newspapers, depicted the

atomic bomb as the human worship of power over reason, threatening to destroy humanity. This was one of the first Brazilian public statements about the atomic bomb. It was a first step in the direction of a very intense debate. Antonio Constantino, a reporter, considered that nuclear proliferation could enslave mankind while atomic control could make Gods of men. Dinah Silveira de Queiroz, a novelist, criticized the bombings as cruel acts of racism. Vinícius de Morais wrote a poem about the overwhelming state of shock resulting from the atomic bombings.

The Brazilian Academy of Sciences issued the nation's most significant statement of concern over nuclear technology in its open letter of 2 September 1945: nations should restrain themselves to the civilian applications of nuclear energy, which should be used as a tool for the improvement of civilization's material conditions and for the "guarantee of freedom and dignity of nations and individuals."[4] Reflecting the national mood, the Academy linked moral concerns with national security. Others, like reporter Benedicto da Costa Neto, wanted the United Nations to deploy the bomb to impose peace. The editors of *Jornal do Commércio*, a Rio de Janeiro newspaper with national circulation, defended the construction of an international system of control, impossible as long as the United States monopolized the atomic secrets.

The tension between Brazil and the United States increased as Brazilians wanted to advance in science and technology and pay for the costs with natural resources, in particular the mineral monazite. The United States wanted the monazite on its own terms and at the same time wished to prevent Brazilian access to nuclear technology. In fact, on 10 July 1945 Brazil had signed a three years treaty with the United States to provide three thousand tons of monazite at a price varying from thirty-one to forty dollars a ton.The treaty could be renewed for ten equal periods. Hiroshima and Nagasaki revealed the real price of the minerals. By 14 August, Brazilian scientists had identified ten major sites of Thorium and Uranium, making commercially viable their industrialization in Brazil, even more so if internal markets could be found for the rare earth salts. MIBRA, Foote, ORQUIMA and other companies exporting the minerals and the salts were all caught in the tension. On 27 August 1946, by recommendation of the Brazilian National Security Council, the Brazilian President, Eurico Gaspar Dutra, terminated the treaty. The United States pressured for a renewal by smuggling monazite and by blocking Brazilian sales to other nations, such as Great Britain. As a result, the need for internal consumption increased and the companies operating in Brazil dwindled. ORQUIMA displaced Foote and MIBRA, which even resorted to armed militias in a final struggle for the Brazilian radioactive sands.

In 1946, the tension became visible also in the United Nations, where the Brazilian representative, naval officer and former President of the Brazilian Academy of Sciences, Alvaro Alberto da Mota e Silva, considered the United States sponsored Baruch's plan an act of expropriation of raw materials. Alvaro Alberto's research articles reveal a full awareness of the scientific, technological, economic and administrative needs of a successful nuclear program. He was also aware that scientists, universities and foundations in the United States, in opposition to their government, supported Brazilian efforts at acquiring nuclear technology. He inspired the 27 August 1945 Academy's motions on nuclear energy. These included a call on the government not only to enlarge existing research institutions but also to create new ones with the active participation of state administrators, industrialists, and scientists. The members of the Academy wanted more and better prospecting of atomic minerals and the training of military and civilian technicians and scientists.

The Academy was not alone. Three institutions, still active today, emerged at this time: The Brazilian Society for the Advancement of Science, The Brazilian Center for Physics Research, and the Brazilian National Research Council. The debate shaped their immediate objectives and structure: to have nuclear energy made an important difference for national security. The Getulio Vargas na-

tionalist government would coalesce an opposition to the nuclear project. This was a right wing opposition to nuclear energy. The project, with a German-Brazil deal at its center, included the Brazilian National Research Council, CNPq, founded in 1951 to promote nuclear research and technology. After interference by the United States the project collapsed in 1954. It re-surfaced in a different form in 1975, but with similar tensions.

The difference was that the scientific community opposed the 1975 nuclear deal. Brazil "imported" the technology of the nuclear fuel cycle. Germans decided on the most significant technologies and the Brazilians held the responsibility. One of the hopes of the Brazilian planners was to meet the needs of internal and external markets - all non-existent now. This nuclear deal failed. Germany failed to transfer this technology to Brazil.

4. Argentina:The Case of Internal Tensions and External Pressures

The case of Argentina presents similarities with the Mexican and Brazilian cases. Nevertheless, two major conflicts dominated the evolution of the Argentine nuclear program and its debate. On the one hand, the United States pressed Argentina on a number of issues, including political and financial ones. On the other, there was a tension resulting from the strains the scientific community suffered under Peron. The two conflicts appeared in 1946, when Argentina attempted a nuclear project. Its faillure opened the space for another try, in 1951, which also failed but brought forth the same conflicts. The current Argentina success has its roots in these attempts.

In 1946, Enrique Gaviola, president of the Argentine Physics Association, described the parameters and design of an atomic bomb and proposed the creation of a national institute for atomic research. He also presented the bill for the creation of a National Research Council. Gaviola's simple but significant plan was to offer Northern Hemispheric scientists the opportunity to work in academic freedom. One of the founders of quantum mechanics, Werner Heisenberg, accepted Gaviola's invitation.

Gaviola's proposal came at the right time. The Argentine Congress discussed three different but related projects between September and December 1946, including a bill to nationalize all uranium ores. Peron backed a military inspired project, opposed by Gaviola and the Physics Association, which would place the scientific institution under the jurisdiction of the Minister of War. According to Gaviola there was a contradiction between military and scientific training and organization. The military required secrecy, but in science this could hide incompetence and charlatanry. While this project failed, Gaviola's had a better chance. Although promising, this serious non-military research program was also dismissed, in great part because of attacks by the foreign press.

On 24 February 1947 the *New Republic*, an United States magazine with world wide distribution, published a grossly distorted and misleading article by William R. Mizelle about "Peron's Atomic Plans" which accused Argentina of "launching a military nuclear research program." It is important to see Mizzele's attack as part of the conflict between Argentina and the United States. Several of the significant American and Argentine reporters writing about Argentina for the world press were linked to American intelligence efforts[5]. Finally, there was the February 1947 American atomic threat to Buenos Aires. Its actual impact is still under study. Both factors contributed to the termination of the Gaviola-inspired projects and, thus, opened the way to the beginning of an adventure which, albeit prominently peaceful, was nevertheless almost unique in its bizarre means and aims.

It is also important to take into account the conflict between Peron and the universities. The conflict resulted in professors badly paid, laboratories without equipment, lack of space and unsupported libraries. For instance Bernardo Houssay was expelled from the University in 1946; he received the Nobel Prize for Medicine shortly after. Gaviola also confronted similar problems. But the majority of the country, particularly the working class,

rural workers and the middle class, supported Peron and his wife Evita. Argentina, transformed during World War II, rich, industrializing and with a political program aiming at an independent and equidistant position between imperialism and communism, could, maybe, become an atomic nation. Since the Cold War had in practice classified most atomic information, Argentina had to proceed on its own.

In conflict with the domestic scientific community, Peron imported German, Austrian, and Eastern European scientists for a number of purposes. Most of these scientists were in fact American or British agents with little interest in building institutions or contributing to the growth of Argentina. Others were not qualified at all, like Ronald Richter who attempted to set up a Peronist cold fusion program. He was recommended by Kurt Tank because of his ideas on nuclear propulsion for flying. Kurt Tank was a German aircraft specialist who designed in Argentina the Pulqui II, one of the most advanced jet fighters of its time and operational in 1951. Tank had led the first wave of experts reaching the River Plate shores in 1947-1948.

Richter reached Argentina on 16 August 1948. He met Peron 8 days later and according to a public statement by the Argentine leader, Richter "explained to me [Peron] all the secrets of nuclear physics" including the control of thermo-nuclear reactions, something considered impossible in those days. Without consulting his assistants, Peron approved the project and asked his old friend Colonel Gonzalez to provide Richter with all he wished.

Richter worked first in a Cordoba laboratory next to Tank's but by early 1949 he moved to Huemul Island on Nahuel Huapi Lake. There he used hundreds of soldiers and tons of material to construct facilities and equipment - several of which he soon ordered to be destroyed. On 16 February, 1951, Richter claimed to have achieved the seemingly impossible task of controlling nuclear fusion. But a technician suspected that the observed temperatures of about 100 000 000 degrees actually resulted from the accidental tilting of the measuring equipment. Richter refused to repeat the experiment.Instead, a week later, he dismantled his experiment and began working on a new configuration with magnets to confine the plasma, completed one year later but never used.

On 24 March 1951, Peron surprised the world with the announcement that an Argentine citizen had controlled a thermo-nuclear reaction. As it is known, the first hydrogen bomb exploded in November 1952 and controlled thermonuclear reactions have yet to be achieved. Not surprisingly, the announcement made large but skeptical headlines all over the world.

Peron continued his nuclear program and in May 1950 he created the Argentine Atomic Energy Commission, CNEA, with Colonel Gonzalez as Secretary General, Peron as president, and Richter and the minister of technical affairs, R. Mende, as members. Not being a physicist, Colonel Gonzalez just accepted the extraordinary powers Peron gave Richter - since 1 March 1951 the President's authority in Huemul Island. Assisted by his son, an air force captain and administrative secretary in Huemul, Colonel Gonzalez kept his faith in the project and did his best to fulfill Richter's ever increasing extravagances. However, the unending requirements for more and better equipment, the insistence on extreme urgency for equipment procurement, soon left aside unused, and especially the repeatedly unkept promises of further and more spectacular results, finally began to have an impact. Colonel Gonzalez urged Peron to send a commission of experts to investigate the validity of Richter's claims. But Peron reiterated his promise of secrecy to Richter. Gonzalez resigned and Navy Captain Iraola Goitia took over. With new and more dramatic evidence, a commission visited Richter's island. As a result Peron ended the adventure in November 1952.

In spite of its extravagant nature, the Huemul project gave rise to several developments. One year after the creation of the CNEA, Peron set up the National Atomic Energy Directorate, DNEA. Colonel Gonzalez became also the director of DNEA and

encharged with a parallel enterprise. Richter had nothing to do what with this latter program. Gonzalez appointed capable people to organize small research groups with outstanding young university graduates. In 1956 the Richter's CNEA was declared defunct and the DNEA became the new CNEA. From this gradual but solid process emerged the Argentine atomic energy programme.

Equipment for the programme came also from the Huemul Project, including a Synchrocyclotron and a Cockroft-Walton Accelerator.In March 1951 Prince Bernhard of the Netherlands visited Peron and in May 1951 the Dutch government commissioned the distinguished physicist Prof. Bakker to offer the nuclear equipment to Argentina and visit Huemul island. Although Richter resisted the visit - claiming that he wanted industrial not scientific cooperation - it occurred. Bakker offered Richter a Synchrocyclotron, then a leading instrument for nuclear physics research instrument, and a Cockroft-Walton machine - not so modern in concept and capability but an easy to use nuclear accelerator. Nevertheless, Richter did not give Bakker license to visit the laboratory installations. Richter recommended the machinery, "for the training center of atomic physicists planned in Buenos Aires." In addition, the Huemul project also had a role in the birth of controlled nuclear fusion research in the United States. Inspired by the Argentine claims, in mid 1951 Lyman Spitzer Jr. of Princeton proposed to the AEC the confinement of plasma in a figure 8-shaped tube by an externally generated magnetic field. This originated the so-called project Sherwood.

Today, Argentina has by far the most articulated nuclear program in Latin America, through which the CNEA has reached good control over nuclear technology. Imported equipment does not hinder local participation and control, with CNEA Argentine technicians doing the engineering. This started in the 1950's with the construction of research reactors. During the 1960's, the CNEA decided for the import of its first nuclear plants. The import vs. export issue was, nonetheless, debated by CNEA technicians and they adopted the first alternative as the means to enlarge participation in the international market. Since the first nuclear plant, Atucha 1, constructed in 1967-1974, Argentine staff imposed a "positive list" of items to be supplied by local industry. Thus they "untied" the package of imported technology. This process led local engineers to develop technological know-how and to progress in independent planning and control. Therefore Argentina is the outstanding case in Latin America, with impact beyond its borders. For instance, Argentina has created the Huarangal Atomic Centre and its RP 10 reactor near Lima, Peru. Countries outside the region have signed similar agreements with Argentina: Algeria, Turkey and Iran, among others. Today Argentina is present in the international market of small, research type, reactors and auxiliary equipment.

5. Recent Common Efforts

Argentina's work in Peru is an example of regional co-operation. Another is the Brazilian-Argentine cooperation program. They, nonetheless, are far from the 1960's proposals. Such proposals - the construction of a common Latin American nuclear program with articulated national industrial capabilities - looked reasonable but led to frustration. The new technology of the common program was to revitalize the Latin American industrial system and assure a common future. It needed economy of scale, and the technologically specific effort of each regional industry could be justified by the integration into the complex of the whole nuclear cycle. But the military implications did not allow the necessary openness required by any industrial atomic integration.

The exception was ARCAL - Spanish initials for the Regional Cooperative Programme for Nuclear Science and Technology in Latin America. This is the only Latin American nuclear program involving multilateral cooperation. Its framework makes possible its extension to all countries in the region. ARCAL concentrates on minor technological efforts,

such as radiation protection, instrumentation, medical, agricultural and industrial applications. This minor effort is what remains from the big promises of a common nuclear program leading to regional integration.

Nevertheless, Latin America does need some common atomic program because the atomic complex is developing anyway in the world. Ignorance of this technology could have serious consequences, mostly in the cases of nuclear accidents. Any nation requires preparedness for exceptional situations. And nuclear technology requires the practical work. Since no Latin American country can reach the scale of investment necessary to sustain a nuclear program, they will have to resort to regional co-operation. Moreover, it is quite clear that recent developments showed that such a scale should not - and must not - be a national priority.

6. Concluding Remarks

The nuclear controversy in Latin America, particularly in Argentina, Brazil and Mexico, spans by now nearly half a century of history, from the days of Hiroshima and Nagasaki. The debate resulted in different ideological sets of beliefs about technology. The opposition or support to nuclear technology set in along three major themes. Actors in the national security debate considered nuclear energy a defense technology. Actors in the economic debate saw nuclear energy as a source of either wealth or poverty. Actors in the moral debate perceived nuclear energy as either something evil or a gift from the gods. The interpenetration of these themes, and of other local and international factors, produced different programes in Argentina, Brazil and Mexico.

The Argentine program of the 1950's left institutional and material inheritances which, after 1955, evolved into a new nuclear program, the most advanced in Latin America. But it is clear that, excepting major turning points, since the failure of the early Gaviola project, the effective nuclear debate in Argentina has been primarily an internal one, inside the institutions promoting the technology. Gaviola had clearly pointed out that without an open debate, research programs could be just disguised charlatanry. Thus, the academic community criticized the Peron-Richter program. Yet as long as state power sheltered Richter's atomic adventures, the project at Huemul Island continued. The extravagant mismanagement of funds and the lack of results removed the state support and protection for the Austrian-Argentine cold fusion program.

What do proponents of a technology do when they cannot resist the pressure of their own national debates? The periphery may provide an answer to their problems, serving as an outlet for the proponents of technology to escape debates, and possible criticisms, in their own countries. Therefore, technology programs which would not be acceptable in Germany could be attempted in Brazil, to be transferred back, after reaching a certain stage of development. In a situation with technology of questionable validity and vulnerable to public and political attack, and a state which cannot shelter the technology with secrecy, the periphery becomes "the tail that wags the dog." Because of this phenomenon, it is quite possible that the actors really play their most important card in the periphery, including the feasibility tests of a dubious technology. Those controlling the debate in the periphery may end up having the most influence on technological development.

The nuclear debate in Latin America points out that there is a technology oriented culture which will seek shelter in the state when criticized by representatives of a humanistic culture. When the state is criticized, even by another state (as when the United States disapproved of Germany) the proponents of the technology may remove it to another region of the globe. A weak state may not resist external pressures. This was the end of the Brazilian program of the 1950's. In 1955 pressure by the United States terminated a first German-Brazilian deal, kept secret because Germany was under occupation. Despite the setback, the network of Brazilian institutions supporting the nuclear program continues to

exist. The Brazilian individuals and institutions supporting the American intervention then, would, in the opposite role, clash with the United States in the post-Tlateloclo period over their support for a new atomic deal with Germany.

Its is interesting that actors changed positions according to whether or not they belonged to the technological program. In Brazil, the positions between military and scientific institutions reversed roles as the decades passed. In Argentina scientists reinforced the nuclear program after the fall of Peron. Another clear example of this is the actual outcome of the debates. The international linkages of the scientific communities plus the dominant political economic patterns led to different, regionally incompatible nuclear programs in Argentina, Brazil, and Mexico. Cuba should also fit the pattern here discussed. While the debate resulted in the establishment of nuclear programs, the specifics were culturally determined. And the only partially successful program required the sheltering of the nuclear technology by the state - in Argentina first by Peron and later by the military.

This discussion may indicate that a scientific culture does not exist per se, but only as a function of institutional interests. Since the scientific institutions are linked to the state or to corporations, their opposition to technological programs will not depend on the nature of science but on the nature of the group of scientists controlling the institutions. This is primarily a function of the political linkages of the scientists and only secondly of any existing (or non-existing) scientific culture. For this reason scientists may individually attack a research program. When they belong to the program they disappear into the working mass of technologists. When they oppose the program, they speak in their own name, and as part of the humanistic culture which they temporarily, and sometimes permanently, join and promote.

NOTES

[1] This study, as well as the project on technology controversies on which it is based, is funded by the Swedish Research Council for the Humanities and Social Sciences, HSFR.

[2] All sources and references for the present text are to be found in Cabral, R. (ed.) The Nuclear Technology Debate in Latin America. Göteborg, Sweden: University of Göteborg. Department of Theory of Science. Science, Technology, Ideology and Culture Series, Volume 1, 1990. This article is based on the papers by Regis Cabral, Mario A. J. Mariscotti and Cesare Giuseppe Galvan which appeared in this volume. A free copy of the volume may be obtained by writing to STIC, Department of Theory of Science, Gothenburg University, S-412 98 Göteborg, Sweden. Small passages, approximately six paragraphs of the present text also appear in the forthcoming volume of proceedings of the XVIIIth International Congress of History of Science, held in Hamburg-Munich, Germany on August 1989.

[3] The group included general Jesús de la Garza, Lemus Tejada, A. Barajas, Carlos Graef Fernández, Alonso Nápoles Gándara, Javier Barros Sierra and Nabor Carrillo.

[4] It was very similar to the Brazilian Academy of Sciences 11 November 1922 motion on the outlawing of chemical weapons.

[5] The reporters included included Mizzele, Prewett, Rufus Bellamy, Stanley Ross, Arnaldo Cortesi, Fernandez Artucio, Taborda, and Sommi.

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