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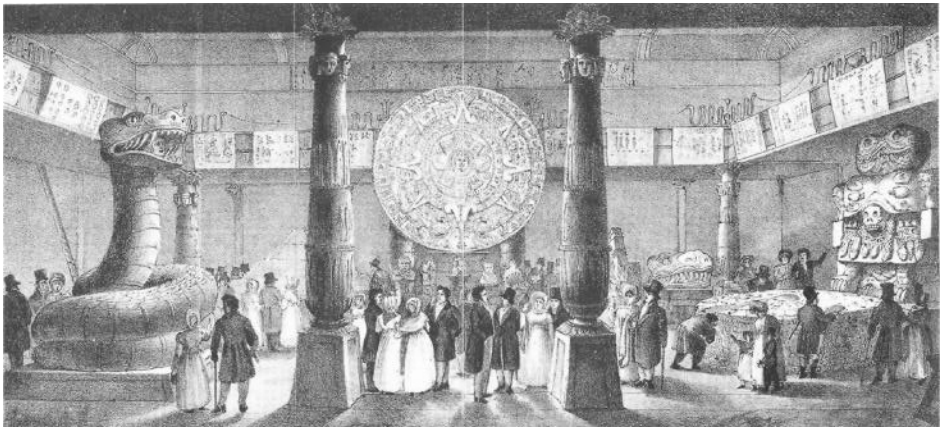

Agostino Aglio, **Engraving of the 1824 Ancient Mexico exhibition**, a collection of New World antiquities, organised by William Bullock at the Egyptian Hall, Piccadilly, London, 1824.

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Editorial Note

By Tiago Saraiva[*]

It is a pleasure to present the second issue of HoST, journal of History of Science and Technology. More so, considering that the current number materializes many of the purposes that justified the launching of the journal. First of all, it includes innovative and challenging, even provocative, ways of writing history of science not commonly found in more established journals in the field. Secondly, it contains contributions heavily indebted to other disciplinary approaches, namely Science Studies, which we deem crucial to enlarge the scope and sophistication of history of science. Thirdly, history of science and technology throws new light into well known subjects, demonstrating its relevance for the discipline of History at large. Finally, it keeps up to the journal´s commitment of geographical diversity, although the Portuguese presence has probably too much weight. But let us be more concrete by referring directly to the articles published.

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In "The Emergence of Early Modern Commons: Technology, Heritage and Enlightenment", Antonio Lafuente and Nuria Valverde develop a powerful argument of looking at the history of science of the Enlightenment as the history of inventing common goods as public patrimony. By following naturalists, archeologists or historians, they describe an all-embracing effort that converted stones, rivers or trees into scientific objects prone to be orderly kept in museums' chest-of-drawers or botanical gardens' plots. As the authors nicely put it, "to say that something acquires the status of a patrimonial good implies that the item is subject to various disciplinary rules." That was the immense task of enlightened scientists: to free native wisdoms or plants from local attachments in order to include them in the placeless space of scientific institutions ready to incorporate the public patrimony. Only after trees were brought to botanical gardens, could forests be governed by imperial bureaucracies; only after placing the Stone of the Sun into the museum did it form part of the collective memory necessary to build a modern State. What were the limits of such project? Apparently, there were none. Everything was susceptible to become public patrimony given that proper technologies were used. The numismatic, documental and archaeological expeditions the authors refer to is perhaps the best example of such enlightened hypertrophy. And this is another of the virtues of the article: subjects of inquire as familiar to historians of science as scientific expeditions are given unexpected twists under the light of this global invention of the commons. Also, the ways of dealing with the history of humanities place them side by side with other scientific

endeavors in a non trivial way, with History taken as a discipline dependent on "technologies of dating and localization" and agreements about the variables defining the signs of progress. The intense use of such technologies turned disconnected fragments of reality into a common good immediately defined as a public good. But by tracing the genealogy of these movements the authors suggestively question the necessity of identifying the common with the public, pleading for alternative ways of conceiving the Commons separated from state undertakings.

The treatment of the concept of Reality that sustains Lafuente & Valverde argument resonates nicely with the discussion carried out by João Arriscado Nunes in "Circulation or (Re)enactement? Performing the Variable Virulence/Pathogenicity of Helicobacter Pylori". By drawing heavily on Karen Barad's "agential realism" and Joseph Rouse's naturalistic approach to science studies, Nunes offers a narrative of the emergence of Helicobater pylori as a biomedical entity. As in the article previously discussed, scientific practices are not taken as simply aiming at disclosing an external reality, but scientists are instead actively involved in producing phenomena that can not be separated from the set of material-discursive practices that enact them. By paying close attention to the apparatuses and practices constitutive of the phenomenon of the variable virulence/pathogenecity of Helicobater pylory, Nunes is able to demonstrate how concepts are only meaningful by reference to those very same apparatuses. He thus rehabilitates the "Materials and Methods" sections of published papers as a crucial source for Science Studies scholars usually obsessed with material from

archives or personal interviews. And if following scientific material practices is a common methodology in studies inspired by Actor-Network Theory (ANT), Nunes is highly critical of the tendency of such scholarship to take the heterogeneity of the world as starting point, with scientists and machines making and unmaking attachments, instead of perceiving it as "the outcome of the practices constitutive of reconfigurations of the world". His paper is thus part of the ongoing effort of better grasping the modes of existence of biological and biomedical entities and how they are enacted as objects of knowledge.

Both Konstantino Chatzis' and Cristiana Bastos' articles have a totally different tone, more familiar to the practitioners of history of science and technology. This said, we consider them excellent examples of the kind of scholarship HoST welcomes. Beginning with Chatzis paper, "Rationalizing Maintenance activities within French Industry during the Trente Glorieuses", we are faced with two major challenges. First of all, it constitutes, to our knowledge, one of the first attempts to approach the rationalization process of the French Trente Glorieuses, trying to place the history of technology at the heart of any proper understanding of a period so crucial in France's history. Secondly, by focusing on maintenance activities it deals with a major issue neglected by historians of technology, usually too much concerned with the history of invention and innovation. When looking at maintenance we are obliged to think how technology really works and in its entire lifespan instead of being concerned exclusively with the moment of emergence of a new technology. Maintenance thus seems to offer new

relevant hindsight of the significance of technology in history, as Chatzis' well crafted paper clearly demonstrates.

Cristiana Bastos' contribution to this issue also sheds new light into a major subject for general historians, the so-called Third Portuguese Empire of the Nineteenth and Twentieth Centuries, that till now has received scarce attention from historians of science. By following the trajectory of the Goan physician Indalêncio Froilano de Melo the author is able to build a narrative that weaves together local health policies, Indian nationalism, Portuguese imperial policies, and colonial historiography. This is even more interesting taking into consideration that when dealing with the Third Portuguese Empire, historians are for obvious reasons normally much more interested in the African colonies than in the decaying oriental possessions. Bastos not only highlights the practices that allow for the circulation of the Goan physician through imperial networks, from Goa to the Metropolis, passing through Africa, but she integrates Brazil (the second empire) as well into her account which allows her to engage in a critique of imperial historiography from a post-colonial point of view. The "in-between" life of Froilano de Melo reveals his dual identity as agency and structure, as both active builder of new imperial networks and as product of a "long established, tense and contradictory society."

This revisitation of well known historical objects by historians of science and technology is a major purpose of HoST. Also Ana Paula Silva's work-in-progress peace, "Portugal and the Building of Atlantic Telegraph Networks", can

be read as a new look to the ways the Portuguese Third Empire was built, highlighting the major role of technology, in this case submarine cables. But her work aims further. The very same nature of her object of research enables the author to integrate the Portuguese empire in the more general history of European imperial history at the end of the Nineteenth Century. By following the political geography of submarine cables, Silva looks at the Portuguese empire through a transnational lens much more powerful than the traditional comparative studies of political historians. Her study not only makes the Portuguese case recognizable for international scholars, but it also suggests that those interested in the development of the British or French empires should pass through the Portuguese empire as well, just as their intercontinental cables did. Such argument fully justifies the weight given to the Portuguese case in the current issue of HoST.

The emergence of early modern Commons:

Technology, Heritage and Enlightenment

By Antonio Lafuente & Nuria Valverde ∗

Our age is rediscovering the importance of commons. Every day we see items in the press directly or indirectly claiming the status of commons for the air, water, the oceans, biodiversity, software and even science itself. And indeed many of the problems facing us are so huge or so complex that they cannot be dealt with on a national basis, but require commitment on a plurinational or even planet-wide scale. Such is the case with CO_2 emissions, AIDS, or Genetically Modified Organisms.

Our subject, however, is not the society of risk but *commons*, that feature of consuetudinary law that has re-emerged from the past and is now claiming our attention. This is hardly surprising, for our world urgently needs to extend common property: that is, those legal entities that are available to all and belong to no one – not even the state. But

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let us not be hasty – for the moment, it is sufficient to state that to the old tension modernity introduced between private and public, between state and market, we must now add a third element – commons. Public administration is no guarantee of the adequate management of common property, proof of which, among many other examples, is the disastrous environmental situation in the former Soviet bloc.[1] In any case, the questioning of public property does not necessarily imply the favoring of private property, unless we ignore the possibility of widening the public domain by means of removing some goods from state control and passing them to civil society.[2]

The casuistry of the reasoning may be complicated, but all the cases quoted above have one thing in common, since we are talking of objects that evolve from the interaction of our environment and our technology. Obviously America existed before it was discovered by Columbus, but it is equally true that as from that year of 1492 its existence, like

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[1] Rachel Carson in her famous, *Silent Spring* (New York: Houghton Mifflin, 1962), depicted the conflict between the environment and industrial corporate interests, denounced the abuses permitted by the capitalist system, and advocated a culture of public regulation. M. Goldman's influential book, *The Spoils of Progress: Environmental Pollution in the Soviet Union* (Cambridge: MIT Press, 1972), made it clear that the disaster was much worse in the so-called socialist states. Later literature has brought more arguments in favor of policies that, as well as limiting state prerogatives, are also less liberal. Also, D. J. Peterson, Troubled Lands: The Legacy of Soviet Environmental Destruction (Boulder: Westview Press, 1993).

[2] The 'Tragedy of the Commons' is simply a failure of management on the part of those who have been unable to limit their individual rights in order to protect the collective good. G. Hardin, "The Tragedy of the Commons", *Science, 162* (1968): 1243-1248. See also the revision of his first determination to recommend private management of common property in, G. Hardin, "Extensions of 'The Tragedy of the Commons'", *Science, 280* (1998): 682-83.

that of Oxygen in 1777, the hidden sources of the Nile in 1858, or the DNA molecule in 1953, acquired a status of a completely new and conclusive character. America, as well as Oxygen, the Nile and DNA became laboratory specimens, objects that could be mobilized by means of maps, formulae and tables. In other words, objects that, without detriment (either then or now) to their importance for human life (or culture), were destined to be the object of great and controversial experiments, whose solution required the cooperation of more experts and new technologies.

The same is true of Michelangelo's frescos, the manuscripts of Qumran or the bones of the child of Lake Turkana that, once appreciated by archaeologists or paleontologists, become objects bearing witness to a past that can only be studied using sophisticated technologies and specialized language.[3] Let us now see these technologies at work.

Technology and consensus

Examining is very simple. It consists of detecting singularities where apparently all is continuously uniform or chaotic. What matters is how we do it and how we evaluate

[3] Let us imagine it was found necessary to restore Velazquez's *Las Meninas*. The move would come up against several groups of defenders, each with their own different orthodoxies, ready to fight tooth and nail to prevent anything being changed beyond mutually agreed limits. The question, of course, is who accepts the agreements (and how, and where) that cannot be altered, and how to evaluate any deviations from the doctrine. These questions lead us inevitably to answers favoring the use of one machine over another, or in other words, preferring one methodology to its alternatives.

things. And, while admitting it is not an easy question, we will venture an answer. It is enough to take an object (social, cultural, material or natural) and to assign it some features, characteristics or properties (local, symbolic, physical or formal), that are tangible according to some discipline (history, archaeology, ethnology, astronomy or botany). If the correspondence between the chosen object, its supposed properties and the disciplines applied is correct, then we have made a gigantic step forward, so long as what we sought to do was to inform and shape the object: in other words, to do things with it such as to measure, date, catalogue, compare, or mix it, etc. And we can see how complicated this process becomes, for these are practices that require ever more sophisticated technologies, from the most accessible scales or tables to the rarest balances or numerical series. The technologies of inscription are very diverse, and all imply the use of more or less obvious catalogues, cartographies, algorithms, machines, perspectives or scales. Thus we reach a first deduction: that each object reduced to or circumscribed by a handful of properties needs to be taken care of, and none can survive without the metonymic and disciplinary practices with which it was first brought to light and then established.

So, water does not need us. But H_2O could not survive without an army of chemists, doctors and engineers to recreate it constantly in their laboratories, their books, their plans or their projects. The explanation is simple: for while parsley is the fruit of evolution, *Petroselinum sativum* is the brainchild of the botanist, as the balance of payments is to the economist, Quipus to the anthropologist, and the current of El Niño to the geographer. All these objects are scientific

creatures, bearing no relation to the existence of primitive or sullied nature. None of these objects is natural; they cannot exist without inventiveness and dexterity. They are artificial and among themselves they weave the fabric of what we call reality, including the periodic table, the explanations of the tides, of fever or of species, not forgetting the theories of error, of combustion, of colors and of value; they form an artificial milieu, created by the concurrence of all our technologies ranging from encyclopedias to statistics, passing through classificatory principles, electrolytic cubes and astronomical tables.

The concept of reality, however, has become too elusive. And anyone determined to maintain the existence of a stable, shared, consistent and universal reference faces the challenge of explaining how we acquired this heritage and how it was able to expand its dominion to such an extent. We shall not repeat the arguments discrediting the tendency to exchange nature for reality. The two things are not equivalents, however hard we may try to naturalize cultural imagery, or however stubbornly we strive to maintain the duality between subject and object. We shall add just one more comment on this point: reality carries such weight in our political and moral imagery because it is always expressed with quantitative factors, proving the existence of a broad consensus on its dimensions and how they are to be calibrated. The strange thing, however, is the enormous effort made by our institutions to suggest that values derive from natural principles and not from a rapport between people and their machines. It is of course true that reality and facts are the same thing, but the problem arises when we wish to discri-

minate between facts and opinions. The introduction of these nuances brings out the experts and all the paraphernalia of gadgets that they use to read the pulse, to take stock, and to draw up genealogies.

No society can survive without some agreements to give a certain stability to its more fragile structures. So nobody denies that values are important, but if there were a group of people with the will to understand each other, opposed to capriciousness and in favor of precision, they would first have to agree on the meaning of these words. We know, too, that they would almost certainly end up arguing about measurable and quantifiable matters, and so would need to decide which machines to use and the protocols needed to order and then communicate the information obtained. In short, they would have to obtain technologies able to dissociate the phenomena from the back yard, from the village, and from ethnic links. So a conversation about values ends up as a debate about screws and adjustments, the calibration of instruments or the distortion of lenses. The important thing in these technologies of disembedding[4] is not whether they are artificial or foreign, but that they act as political instruments to create a new consensus. They are in conse-

4 Anthony Giddens explained this clearly when he proposed that *disembedding* (lifting out) was one of the typical circumstances of modernity. See his, *The Consequences of Modernity* (Cambridge: Polity Press, 1990), 88. See also, Ph. Brey, "Space-Shaping Technologies and the Geographical Disembedding of Place," in *Philosophies of Place: Philosophy and Geography*, ed. A. Light and J. Jonathan Smith (New York/London: Roman & Littlefield, 1998), 239-263.

quence moral machines and the basis of civic order. Without them there would be no social contract.[5]

If civility is a technical matter, efficiency is a moral challenge.[6] Our world is obsessed with the problems associated with the management of time, including those whose roots are historical. Implicitly or explicitly we are told over and over again that to explain something is to relate history, and when we question this adulation of time, there emerges the conflict between modernists and post-modernists. But

5 For more details on how instruments produce values and consensus on scientific practice and the production of reality, see L. Daston, "The Moralized Objectivities of Science", in *Sonderbruck aus Warheit und Geschichte*, ed. W. Caarl and L. Daston (Göttingen: Vandenhoek and Ruprecht, 1999), 78-100. On the material conditions of this consensus it is also worth considering, A. Pickering, "Living in the Material World: on Realism and Experimental Practice", *The Uses of Experiment. Studies in the Natural Sciences,* ed. David Gooding, T. D. Pinch, and S. Schaffer (Cambridge/New York/Melbourne: Cambridge University Press, 1992) 275-297. On the minimum characteristics of technological consistency and the margins of flexibility permitted by the local adaptation of machines see, M. De Laet and A. Mol, "The Zimbabwe Bush Pump: Mechanics of a Fluid Technology," *Social Studies of Science, 30* (2000): 225-263.

6 The association of efficiency with moral values is determined by two aspects. First, by the association of scientific results with epistemic values related to rigor, objectivity, accuracy and disinterest, applied to do away with any suspicion of any possible arbitrary manipulation of the results. See, L. Daston and P. Galison, "The Image of Objectivity", *Representations, 40* (1992): 81-128; S. Schaffer, "Astronomers Mark Time: Discipline and the Personal Equation," *Science in Context, 2* (1988): 115-145; P. Dear "From Truth to Disinterestedness in the Seventeenth Century", *Social Studies of Science, 22* (1992): 619-632. But secondly, too, due to the emergence of biopolitics that have to use broader degrees of precision in order to guarantee that the task of government may be centralized: I. Hacking, *The Taming of Chance* (Cambridge: Cambridge University Press, 1990); T. Porter, *Trust in numbers. The Pursuit of Objectivity in Science and Public Life* (Princeton: Princeton University Press, 1995); A. Rusnock, "Quantification, Precision and Accuracy. Determinations of Population in the Ancien Régime", in *The Values of Precision*, ed. N. Wise (Princeton: Princeton University Press, 1995), 17-36.; A. Lafuente and N. Valverde, "Linnaean Botany and Spanish Imperial Biopolitics", in *Colonial Botany. Science, Commerce, and Politics in the Early Modern World*, ed. L. Schiebinger and C. Swan (Philadelphia: University of Pennsylvania Press, 2004): 134-147.

there is another conflict that cannot be ignored: that sets natural against artificial, that imposes on our machines an existence separate from that of our bodies. Such a statement ignores the fact not only that they are extensions of our own sensitivity, but also the creators of our sociability. Our world can no longer afford the abstractions implied by the separation of ideas from the techniques that produce and mobilize them. The discussion we wish initiate is not that which supports the importance of history, but that which demands that we pay greater attention to technology. What is in question is not whether we are post-modernists, but what remains before we accept our destiny as post-humans. In short, to try to distinguish between subject and object is an effort that will end in despair: in the *polis* all we can talk about is the reality arising from the actions of weighing and measuring; so long, that is, as we introduce some artifact capable of producing the figure that defines the object or, if you will, creates it.

The discipline of treasures

Anyone finding a meteorite of uncertain origin and unknown composition, whatever its size or location, knows at once that it will augment human heritage, and that its place is in a museum. How do we know that it is treasure? We do not in fact know, even though the ability to make this sort of judgment is one of the main objectives of the educational

system.[7] The merit, however, lies in realizing that a lump of stone (or a bone, a carving, a manuscript or a germ) is an object of great value, that can only be confirmed by someone who has the sensitivity and, above all, the tools needed to objectivize certain determining features. From this it follows that the relationship between heritage and technology is so close.

No doubt many people will understand it, but it is difficult to justify the fact that France has more than 4,000 museums and a list of buildings with 188,315 entries, of which 41,812 are classified as historical monuments[8]. It is clear that those who realize that the roots of identity lie in

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7 On the early stages of the development of this sensitivity and its popularization, see A. Secord, "Botany on a Plate. Pleasures and the Power of Pictures in Promoting Early Nineteenth-Century Scientific Knowledge", *Isis, 93* (2002): 28-57; S. Schaffer, "Natural Philosophy and Public Spectacle in the Eighteenth Century", *History of Science, 21* (1983): 1-43; L. Stewart, *The Rise of Public Science. Rhetoric, Technology, and Natural Philosophy in Newtonian Britain, 1660-1750*. (Cambridge, Mass: Cambridge University Press, 1992).

8 See http://www.culture.gouv.fr/public/mistral/merimee_fr). As far as architectural heritage is concerned, there are in France 263,526 items listed, of which 107,319 have been declared historic monuments. The number of publicly owned museums is about 1,400, according to the European Museums' Information Institute (http://www.emii.org/map/fr.htm). The Ministry's register of Spanish property runs to 43,521 items (http://www.mcu.es/bases/spa/inbi/INBI.html), but in the list is still incomplete. The most amazing case of heritage inflation seems to be that of the United Kingdom. There the number of places, monuments or buildings that are considered part of the national historic or natural heritage and which enjoy some kind of legal protection has risen from about 1,000 in 1945, to nearly 10,000 in 1960, to the figure of a million today. The situation has led P. J. Boylan to reflect on the tendency to conserve 'practically any conceivable element of an often newly-invented heritage' and the fossilization of city centers. See his "The Heritage Dimension in late 20th Century Culture", Research Paper for the Council of Europe's Task Force on Culture and Development, 1994-95. A general assessment of the financial problems associated with heritage management is to be found in, Economics and Heritage Conservation. A Meeting Organized by the Getty Conservation Heritage (Los Angeles: Getty Cenmter, 1998), accessible on-line http://www.getty.edu/conservation/resources/econrpt.pdf

heritage are legion; but sadly we still do not know what the term means, much less when it is written in the singular. We apologize to anthropologists, to the publishers of *National Geographic* and antique-dealers, also to tourist companies and the legion of conservationists and restorers: we plead guilty to not understanding what identity is. We do not know how to measure it, nor what to compare it to. We know this is an unpardonable sin, now that so much is spoken about multiculturalism. If identity is so important, why not declare the whole country as our patrimony? Why should museums have boundaries? The simplest answer is financial, for it is very expensive to maintain the heritage. And moreover it has always been a controversial subject. An excess of public patrimony will not only exhaust the state's resources, but can give rise to a spiral of conflicts that is very difficult to deal with.

Let us look at an example. 1790 was a great year for Mexicans of Spanish descent. A few months apart, and only yards from the great centers of metropolitan power (the viceregal palace and the cathedral) were found the Stone of the Sun and the *Coatlicue,* two pieces that alone would be enough to fill a museum and to satisfy much hunger for the past. And this was indeed what happened, for exalted settings were ordered for both of them. The former, the so-called Aztec Calendar, a twenty-five-ton monolith of about 3.60 meters in diameter, was fixed to the wall of the temple itself and the second was displayed in the courtyard of the University. The Viceroy Revillagigedo, as we can see, took advantage of the opportunity to display the pride of his victorious bloodline, greater still when compared to the earlier achieve-

ments of those natives. If in the Iberian Peninsula archaeologists were discovering their Roman inheritance, those in the colonies were not going to turn their noses up at the legacy of the Aztecs. But the word inheritance, then as now, was a hotbed of conflict. The pieces were as beautiful as they were complex, a real trophy for anyone who was aware of the discoveries being made on the other side of the Atlantic, in Naples, Mérida or Córdoba.[9]

Antonio León y Gama (1735-1802), a brilliant *criollo* astronomer and scholar, soon published a beautiful treatise in which he was able to exhibit his exquisite and unusual erudition.[10] Both stones were a priceless object of study, a case that would prove beyond doubt the breadth and rigor of pre-Columbian astronomical and mathematical knowledge.

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9 See, G. Mora, *Historias de mármol. La arqueología clásica española en el siglo XVIII* (Madrid: CSIC, 1998); J. Arce and R. Olmos, eds, *Historiografía de la arqueología y de la historia antigua en España (siglos XVIII-XIX),* (Madrid: Ministerio de Cultura. 1988); A. Mestre, *Apología y crítica de España en el siglo XV*III (Madrid: Marcial Pons, 2003).

10 In the second half of the eighteenth century there took root in the intellectual world of New Spain a current of thought warning of the need to set up museums to bring to light the cultural, scientific and anthropological characteristics of the country and its different regions. The works by Francisco Xavier Clavijero, *Historia antigua de México* (1780); José Antonio Alzate, *Las antigüedades de Xochicalco* (1791); Antonio de León y Gama, *Descripción histórica y cronológica de las dos Piedras* (1792); as well as the impressive example that Lorenzo de Boturini set to his contemporaries when he complied the greatest collection in Mexico of codices and written material; or, later, the exploration undertaken around 1805 by Guillermo Dupaix and the artist José Castañeda through the Mexican altiplano and South-eastern areas, in search of monuments of archaeological value and high plains and antique objects under the auspices of Carlos IV; all formed part of a huge movement to rescue antiquities. See, E. Florescano, "La creación del Museo Nacional de Antropología y sus fines científicos, educativos y políticos", in *El patrimonio cultural de México* (México DF: FCE, 1993); J. Cañizares-Esguerra, *How to Write the History of the New World. Historiographies, Epistemologies, and Identities in the Eighteenth Century Atlantic* World (Stanford: Stanford University press, 2001).

They were both symbols of an ancient grandeur that had not been lost but only hidden or, rather, repressed: two treasures on which native science and native politics could be founded. But in the case of the Coatlicue, the number of heirs was not to be limited to two, for the Indians saw in those stones a relic that revived their sacred ancestral rites, and lost no time in going to visit it. The authorities soon realized that the Indians had not gathered due to 'national pride' or, as was to be expected of a man of the Enlightenment, 'to contemplate one of the great works of their ancestors', but for reasons that were classified as fanaticism and idolatry. The consequences were immediate: they were forbidden to enter the University Courtyard and the order was given to bury the piece there and then to avoid any form of paganism.[11] The same object, then, passed through the three conditions of trophy, treasure, and relic, unequivocally showing its boundary nature,[12] midway between as many worlds whose practices and cosmovision appeared theoretically insurmountable. However, time will vindicate the person who is able to activate the object in the most effective way. In this case, it was León y Gama who initiated a tradition of research capable, in one discourse, of

[11] J. Alcina Franch, *Arqueólogos o anticuarios. Historia antigua de la Arqueología en la América española* (Barcelona: El Serbal, 1995), 122.

[12] The concept was introduced by Star in order to identify intellectual tools shared (and used in different or peculiar ways) by several communities of practice: S. L. Star, "The Structure of Ill-Structured Solutions: Boundary Objects and Heterogeneous Distributed Problem Solving," *in Distributed Artificial Intelligence*, ed. L. Gasser and M. Huhns (San Mateo: Morgan Kaufmann, 1989). Gieryn has broadened the concept to allow things, processes, peoples or ideas to attain the status of 'boundary', so long as they are capable of permeating through the limits separating different social orders. T. Gieryn, "Boundaries of science," in *Handbook of science and technology studies*, ed. S. Jasanoff, et al. (Thousand Oaks, CA: Sage Publications), 393-443.

fusing together the credibility of mathematical formulae, the accuracy of archaeological testimonies and the legitimacy of ethnographic memory. Everywhere scholars faced similar crossroads. Resolving the conflict between local culture and scientific practices was equivalent to clearing the way for to the formation of the modern state. In order to globalize native wisdom, realizing its value and loosening it from its ties, it had to be explained in the language of the newly emerging bureaucracy, or if you prefer, using the conceptual conventions and experimental tools of modern science.[13] (Lafuente, 2000).

Things were not much different back in Spain. Concern for the decadence of ancient glories (Biblical or Imperial) had to be explained, in the words of the lawyer Juan Sempere y Guarinos, the staunchest apologists of the Spanish King Carlos III and his reign, 'because neither the prudence nor the unhappiness of nations is the product of mere chance' (Sempere y Guarinos, 1788 (I): 18). And of course in order to find the cause of a decline it is necessary to have objectivesation procedures that can be checked. At that point history ceases to be a chronicle and a hagiography, and becomes a public enterprise, discipline-based and thus political. And since the search for explanations needs to be very methodical and demands a good deal of information and many calculations, scholars devote themselves to looking into the past for glimpses of strategies, inventions, calculations or traces that

[13] A. Lafuente, "Enlightenment in an Imperial Context: Local Science in the Late-Eighteenth-Century Hispanic World," in *Nature and Empire: Science and the Colonial Enterprise,* ed. Roy MacLeod, Special issue of *Osiris, 15* (2000): 155-173.

might reveal an order that could evolve and/or decline. At this point there were problems aplenty, but there were two whose urgency was most pressing: first, the preparation of technologies of dating and localization, the *when* and *where* expressing historic statement; and the second was to agree on the variables (technological inventions, architectural constructions, productive processes o graphic representations) whose traces could define the arrow of time, or the signs of progress. To place a group of artifacts, virtual or mechanical, within the course of history meant seeing the world of inventions as an achievement that, unlike that of art, was by nature collective and familiar, the anonymous fruit of (local) improvement and (secular) imitation of widespread practices.

The consequences were spectacular. Technical knowledge also had to be a common, circulating freely, demanding a novel system of patents, greater recognition for model-makers and draughtsmen, and an uncompromising war against the craft guilds[14]. And historians too had a task before them, for the value of things is confused with the difficulty of producing them and, as a result, the objects that give evidence of any calculable degree of skill or civilization are no longer lumps of stone or scribblings. Yes, we do have a

14 See A-H. Thamer, "On the Use and Abuse of Handicraft: Journeyman Culture and Enlightened Public Opinion in 18th and 19th Century Germany", in *Understanding Popular Culture. Europe from the Middle Ages to the Nineteenth Century*, ed. S. L. Kaplan (Berlin/New York/Amsterdam: Mouton, 1984), 275-300; L. Hilaire-Pérez, "Invention and the State in 18th Century France", *Technology and Culture, 32* (1991): 911-931; L. Hilaire-Pérez, *L'invention technique au siècle des Lumières*, (Paris: Albin Michel, 2000). For the Spanish case see, A. M. Roncal, *Gremios e Ilustración en Madrid (1775-1836)*, (Madrid: Actas, 1998); and, on economic policies associated with guild politics, E. Lluch, *Las Españas vencidas del siglo XVIII. Claroscuros de la Ilustración* (Barcelona: Crítica, 1999).

common past (belonging at the same time to everybody and nobody); and the second novelty is that it is technical. What can be imitated from our past are its processes, hidden or forgotten, and so we achieve that strange squaring of the circle whereby the technologies of the past are seen as the root of a common heritage and the leitmotif of a discourse capable of homogenizing the plurality of local or regional histories. What León y Gama did, what Sempere y Guarinos wanted to do, was to study the technical accomplishment imprinted on those stones and to put them forward as a shared model. The importance of the past and its witnesses is not in doubt. This is a history whose interest grows as it reflects more and more technical splendor: 'A building', wrote in 1790 José Antonio de Alzate, Mexican priest, journalist, and one of the most famous scientists and intellectuals of his time, 'shows the character and culture of the people: for it is clear that civilization or barbarism are manifest in the progress that nations make in sciences and arts'.[15]

Much has been written about scientific expeditions of the eighteenth century, and there is an abundance of texts describing the broadening of botanical, medical, geological and geographical knowledge. And there is no shortage of reflections of the interest in anthropological, ethnographic, and geographical matters. However, it must be admitted that

[15] Quoted in Alcina Franch, *Arqueólogos o anticuarios,* 113 (cit. n. 11). J. Sempere y Guarinos followed the same line in his *Historia del Luxo, y de las leyes suntuarias de España* (Madrid: Imprenta Real, 1788). Recalling the works of Tarquinius, one of the Roman kings who devoted most attention to public works, he writes: 'These public works cannot have failed to influence in the minds of the Romans the love of fine arts, and the ideas of taste, comfort and delicacy that are regularly imparted thereby'.

we still have some way to go in understanding the scope of the expeditions whose objectives were documental, archaeological or numismatic. It appeared more and more urgent to explore the formation of collections and the traffic of objects from antiquarianism to academicism, and from private hands to public collections[16]. Indeed, there was a collecting fever that was paralleled by a proliferation of excavations and violations. If proof were needed, here is a document convincingly showing the Enlightenment's drift towards monumentalist hypertrophy. It is a Royal Decree of 6 July 1803, prepared following an Instruction from the Real Academia de la Historia,[17] on how to collect and conserve ancient monuments: '*By ancient monuments shall be understood statues, busts and bas-reliefs of whatever material, temples, sepulchers, theaters, amphitheaters, circuses, naumachias, palaestras,*

[16] As new goals were identified for collections, objects were purged or reorganized. The case of Kircher's Museum, that would cease to be a Gallery of Art and Mechanics and was turned into a Museum of Classical and Ecclesiastical Antiquity, has been considered paradigmatic. See, P. Leturia, « Contributo della Compagnie di Gesú alla formazione delle scienze storiche » in La Compagnia di Gesú e le scienze sacre. Conferenze commemorative del quarto centenario dalla fondazione della Compagnia di Gesú tenute alla Pontifica Universitá Gregoriana, 5-11 November, 1941 (Rome : Universitatis Gregorianae, 1942). In the European sphere, literature on collections has grown considerably since the works of O. Impey and A. MacGregor, *The Origins of Museums: the Cabinets of Curiosities in Sixteenth and Seventeenth Century Europe* (Oxford: Clarendon, 1985); K. Pomian, *Collectionneurs, amateurs et curieux: Paris, Venise XVIe-XVIIIe siécles* (Paris: Gallimard, 1987); P. Findlen, *Possessing nature: museums, collecting, and scientific culture in Early Modern Italy* (Berkeley / Los Angeles/London: University of California Press, 1994). However, we are not aware of any specific studies showing the evolution of the implicit value of each collection, not only from an economic point of view but also the legal status acquired by objects when they are introduced into spaces that change ownership.

[17] The so-called 'Instructions of the Marqués de la Ensenada', drawn up in 1753 to facilitate the performance of the archaeological commission aimed to produce a history of Monumental Spain, forerunners of those of 1803 that must be classed as the first document for the protection of the Spanish archaeological heritage.

baths, roads, paths, aqueducts, stones or inscriptions, mosaics, coins of whatever type, cameos: pieces of architecture, milestones; musical instruments, such as rattles, lyres, bells; sacred [instruments] *such as amphorae, ladles, crosiers, sacrificial knives, axes, stoups, vases, tripods: arms of all types, such as bows, arrows, slingshots, quivers, shields; civil* [instruments] *such as scales and their weights, balances, sundials or clocks, armillary spheres, necklaces, crowns, rings, seals: all kinds of utensils, instruments of liberal and mechanical arts; and finally whatever things, yet unknown, held to be ancient, whether Phoenician, Roman, Christian, whether Gothic, Arabic and Medieval*'. In other words: everything is of interest.

To say that something acquires the status of a patrimonial good implies that the item is subject to various disciplinary rules. The first seeks to define it according to the available technology, whether to determine its composition or age, or to reduce it to a plan or to fix its dimensions. Chemistry, chronology, and planimetry, among other branches of knowledge, act as auxiliary sciences and their judgments are important for everything relating to the preservation of the piece. As we have said, an object is only properly defined when the parameters determining its characteristics as well as the procedures employed to measure them are made public. To give an object historical value is tantamount to giving it scientific and legal substance. We are talking, then, of a heritage that can only be constructed by the intensive intervention of our technologies and, as a result, that can only be defended (preserved) if we keep variations of those parameters defining its value within reasonable limits.

The second discipline we mentioned is the market. By protecting something against commercial exchange, we favor the emergence of a traffic, public or private, in similar objects or simply in copies.[18] Museums play a decisive role here, for in the same way that facts acquire credibility when they are experimental, so the value of objects increases a hundredfold when they go into a museum. The laboratory and the museum thus act as launch pads, favoring movement through two different but complementary networks: that of scientific objects and that of patrimonial objects, in other words, that of science and patrimony. And just as in the eighteenth century botany could not survive without apothecaries, gardeners, and artists; the same applies to archaeologists without the swarm of dealers, collectors and valuers. It is not easy to tell a researcher from a valuer and, wherever we look, we will always find little huddles of experts, scholars, specialists and charlatans arguing over the object, shaking it about, and transferring it into other hands.

The politics of the chest-of drawers

In modern Peru the name of Saint Peter – San Pedro – is still used to identify dozens of rivers, a colonial legacy

[18] The clearest indication of the traffic generated by museums is surely the increasing development of technologies for the detection of fakes, and the market ratings of artistic reproductions. See, M. Jones, ed., *Fake? The Art of Deception* (London: British Museum Publications, 1990; J. Keller, "Print market changes, reacts to tough year; Art Business News' survey of 414 gallery owners reveals trends in the world of published art", Special report in *Art Business News*, October 15, 2002, on http://www.findarticles.com/p/articles/mi_m0HMU/is_7_29/ai_88577350

totally unacceptable to an apprentice bureaucrat. Nonetheless, there they are, all different but linked together by the same two words. Any civil servant would have used the Christian calendar of saints and established a straightforward relationship between heavenly beings and earthly features. To ensure the tidiness of the result he would have adjusted his workspace to suit the object under research and installed accordingly chests-of-drawers with index cards ordered alphabetically, one per river, to avoid duplications. A sketch-plan of the room, then, would show the location of the large number of filing cabinets required; for, as well as rivers, there were convents, plantations, and estuaries to be administered. And, to finish the parable, he would discover that plans, drawers, and saintly calendars are a very efficient tool for controlling the territory. Certainly the repeated appearance of Saint Peter would be considered an abuse (of religion) and an error (of management). And nobody can be blamed for the mistake, because it only becomes apparent when somebody checks the sketches, when the will to govern replaces the will to dominate, and not a single street or gully remains outside the Grand Picture. And so that all these pieces can fit, they must be submitted to symbolic violence so disproportionate that it becomes necessary to found an Empire. We do not mean force, but management. That is, common codes and shared language. Science and Empire are thus mutually cause and effect. They do not coincide, but they do determine each other.

It seems very problematic. In fact, it is necessary to share the illusion that things can be fitted into letters, ciphers, outlines, marks, gradients, or currents. In short, that

they can be transferred to a plan, that the plan can be a piece of paper, and that the raw materials, the processes and the place where it was made can be filed, on another piece of paper inside a cabinet. It is necessary, but we know that it is not enough. What distinguishes a geographer from a filing clerk is the former's status as a witness. And the same could be said of a botanist or an astronomer, which are other skills calling for fieldwork: *in situ* scholars.[19] People who go off in search of their objective and bear witness of its manifestations. Experts who, as well as their own persons, move data, instruments, paper. And this all gives them an influence over what they observe and record, as it does over those who send them and those who listen to them. Upon their return both observers and those who sent them admit the possibility that their papers enable knowledge and action from a distance[20].

An enlightened scholar needs no explanation of expeditions or suchlike *technoscopes*. Especially not if we think of the second half of the century, when courts on both sides of the Atlantic were seized by a fever for the accumulation of data, drawings, maps, plants, rocks, bones, shells, textiles, books, arms, catalogues, dictionaries, plans, minia-

19 The moral and epistemological qualities they should possess have been described by, among others, J. Pimentel, Testigos del mundo. Ciencia, literatura y viajes en la Ilustración (Madrid: Marcial Pons, 2003) ; D. Outram, "New Spaces in Natural History", in Cultures of Natural History, ed. N. Jardine, J. Secord and E. Spary (Cambridge: Cambridge University press, 1996), 249-265.

20 See J. Law, "On the Methods of Long-distance Control: vessels, Navigation and the Portuguese Route to India", in Power, Action and Belief: A New Sociology of Knowledge?, ed. J. Law, Sociological Review Monograph 32, (Routledge, 1986) ; S. J. Harris, "Mapping Jesuit Science: The Role of Travel in the Geography of Knowledge", in The Jesuits: Cultures, Sciences, and the Arts, 1540-1773, ed. S. J. O'Malley, (Toronto: UTP, 1999), 212-240; P. Carter, The Road to Botany Bay. An Essay in Spatial History (London: Faber, 1987).

tures, models, porcelain, tapestries or machines and other historical objects. The expedition is much more than a journey of the erudite, for it implies many commitments, ranging from the support of a sovereign to the coordination of an accumulation of activities and people all aiming towards one goal , calling, at the very least, for agreement on instruments, language, formalities and hierarchies. An expedition can be seen as a great artifact, a sort of mobile toolbox, full (like ships) of human and non-human actors, and where we cannot judge in advance which of the protagonists is working as an extension of the other. We do not know now, and Alzate did not know then, when with his proverbial irony he wondered aloud why, in order to talk about a plant it was necessary to hide all that was known about its location, surroundings, flowering season or soil type.[21] It seems absurd, but that is how it was. We know that the Linnaean system operates a very efficient interface, although it is insensitive to local and seasonal circumstances. And nowhere could the *criollos*- those of Spanish descent- ever agree for, as Alzate *'[...] it is a remarkable thing that the slow-wittedness of a man, however studious and observant, as we suppose Linnaeus to be, should wish to inspect the troops of the whole globe in order to record them, impose new names, and tell them where they should stand'*. His perspicacity is indeed astonishing, because very few could see the enormous

[21] See A. Lafuente and N. Valverde, "Las políticas del sentido común: Feijoo contra los dislates del rigor," in *Feijoo, hoy*, ed. Urzainqui, I. (ed.) (Oviedo: Fundación Gregorio Marañón / Instituto Feijoo de Estudios del siglo XVIII, 2004) 131-157; S. Müller-Wille, "Joining Lapland and the Topinambes in Flourishing Holland. Center and Periphery in Linnaean Botany", *Science in Context, 16* (2003): 461-488.

disproportion there was between the hugeness of the world and the smallness of the laboratory. The Cabinet of Uppsala, its brilliant occupant and his however-many chests-of-drawers were too small to hold the world. Nowadays we would never question these extremes, but from a distance they are poignant.

This disproportion is no less evident when instead of books, be they treatises or inventories, what we wish to inaugurate are museums. Here the Enlightenment was at least up to the standard of the present day. And as we are talking about an enclosed area that can only display what fits inside it and what we can conserve, nothing is more predictable than the appearance inside it of accommodation devoted to simulation or replicas, such as wax-modeling rooms, model-making studios, restoration laboratories and taxidermy workshops. Elsewhere the shelves are more than mere furniture, since they function as media adapted to the object to be legitimized. Any item falling into this framework of planks will be forever divorced from its place and culture of origin, as well as drafted into another scheme of meanings. It is no coincidence that all natural history collections look the same. In its apparent simplicity or familiarity, the labeled grid of shelves acts as an indispensable device for preserving names.[22]

[22] On the physical organization of scientific material and the movement of reference see, Bruno Latour, L'espoir de Pandore. Pour une version réaliste de l'activité scientifique (Paris: La Découverte, 2001), chap. 2; the epistemological and political texture underlying these apparently simple processes is amply dealt with in G. C. Bowker and S. L. Star, Sorting Things Out: Classification and its Consequences (Cambridge, Mass: MIT Press, 1999); J. Fabian, Time and the Other. How Anthropology makes its Object (New York: Columbia University Press, 1983).

This is the fundamental difference from Cabinets of Curiosities. In effect, a museum of the Enlightenment was the epitome of modern rationality, since it combined the four activities of naming, knowing, disseminating and owning in inseparable parts of the same move. For this reason modifying a museum means putting many specialists to the test as well as (and this is what we find most remarkable) the stable or stabilized fabric of ordinary experience: in other words, the agreed ways of looking at and dealing with our surroundings. So a museum is also a boundary object. It does not belong exclusively to the experts who handle the pieces they keep within, but also to those who want to buy and sell them: in other words, all those who think that museums hold everything worth conserving, everything we need to pass from generation to generation, whatever it costs in terms of budgets and officials, or in terms of inventories, laws and buildings. When in 1821 the British Museum set in motion a process of *aggiornamento* to get rid of its old Linnaean organization, D. Stewart Traill, in charge of the collections, protested indignantly: 'I am opposed', said the naturalist,' to any unnecessary change in nomenclature; [...] the adoption of such an innovation in a private collection would be ascribed to bad taste; in a new book they would draw down wholesome castigation of the reviewer; in a public museum theu merit the reprobation of every true friend of science'.[23] Museums, we are told, cannot be anyone's caprice: they were conceived to stabilize the world; they are above fantasy, opinion, and

[23] Quoted in McOuat, "Cataloguing power: delineating 'competent naturalists' and the meaning of species in the British Museum", *British Journal of History of Science, 34* (2001): 1-28, on 10.

even theoretical invention. Museums would only survive as the depositary of common sense.

Whatever they may be, the fact is that very soon after they opened they were already seeking autonomy with respect to the projects with which they had originated, and were asking for resources of their own to organize journeys and to complete their collections, or to fill the gaps on their shelves.[24] And so the museums entered the bidding to obtain objects, encouraging the extravagant market in scientific objects mentioned above. Many arguments were wielded in defense of this ambition to complete collections, but they never failed to mention usefulness to the nation, national prestige or scientific education.

In botanical gardens problems took a very novel form, since to give full account of natural variety implied deploying a policy of transplantation (not just of acquisition) that raised the greatest economic and business expectations. To bring a collection of minerals or American ruins to the court in Madrid was the dream of every enlightened courtier, but reproducing floral wealth in an enclosed site was an ambition shared by all the political economists of Europe. There is no shortage of examples to help us to understand the new

24 This is the case of the Spanish Real Gabinete de Historia Natural (Royal Natural History Cabinet), that from 1777 onwards received the zoological and mineralogical samples collected on different expeditions. In the Gabinete the materials were classified, ordered and evaluated, making suggestions according to fields of interest. From 1793 onwards, however, expeditions began to be organized from the Gabinete with a view to filling the gaps of important objects it should contain. See, A. Barreiro, *El Museo Nacional de Ciencias Naturales* (1773-1935) (Aranjuez: Doce Calles. 1992), 89. It was this practice that would justify the organization of expeditions such as that of Molina, the Heuland brothers and that of Gimbernat to the Alps, as well as numerous explorations in Spain carried out, among others, by Talaker, Molina and Vilella.

relationship that was arising between research, preservation and exploitation of natural resources. And none better than the forest.

When wood began to run short, botanists began to look upon the forests as storehouses of trees. And the culture of protectionism was gaining followers. However, no threatened species could be protected without the prior intervention of scientific research defining its particular qualities. Indeed, nobody can preserve an unfamiliar species: in other words, the management of a crisis (such as, for example, that arising from the extinction of trees used in naval construction) is considerably better when it is possible to identify the particular attributes (always associated with a species) that are to be promoted. The study of plants, the exploration of territory, the establishment of businesses and the protection of woodland were activities that were interconnected in many different ways. Still it is impossible not to see the close relationships built up by botanists between the garden as an experiment and the forest as a laboratory.[25] Yet there is also an obvious correspondence between the garden as museum and the forest as a storeroom. So much so that those of the Enlightenment turned the forest into an extension of the garden, and passed laws about its use as if it were in the public domain, subject to the dictates produced by scientists and engineers.

But here too, as was to happen in the case of questions of nomenclature or even of therapeutic uses, the *criollos* put

[25] See, N. Broc, Les *Montagnes au siècle des Lumières. Perception et représentation* (Paris: CTHS, 1991).

up a strong resistance, for protection was equivalent to a freeze, destroying much revenue from the timber business, including the taxes collected by the local authorities: 'as long as the laws of nature do not fail us', declared the Corporation of Quito, 'there will be forests to spare in Guayaquil without need of Decrees to provide for their preservation'.[26] And in Cuba things were seen in much the same way: 'it is morally impossible', asserted the protest from the Royal Consulate about the measures that sought to prevent the depletion of the woodlands, 'that it can be proved in the natural order of things'.[27] Those who talk like this seem convinced that botany capitulates outside the enclosure of the garden, for the laws governing open spaces maintain an order that only the natives understand.

In any case, we shall not go any further into the credibility of the two positions, obviously based on evidence that is as shaky as the two conflicting languages (or types of

[26] Towards the end of 1778 the President and Visitor of the High Court of Quito, José García de León y Pizarro, alerted by reports such as that of the engineer Francisco Requena (1743-1824), warning that certain forest areas were thought to be 'quite exhausted', issued an Order aimed at the protection of the forests of Guayaquil. The Corporation, that until then had tried to ensure that timber should be taxed in favor of the city, invoking the damage that could be caused by uncontrolled felling, now reacted declaring its total opposition. M. Laviana Cuetos, "Los intentos de controlar la explotación forestal en Guayaquil: pugna entre el cabildo y el gobierno colonial," in Ciencia, vida y espacio en Iberoamérica, Vol. 2, ed. J. L. Peset, (Madrid: CSIC, 1989), 406-407.

[27] Quoted in C. Naranjo Orovio, "Los reconocimientos madereros en Cuba (1780-1810)," in *El bosque ilustrado*, ed. M. Lucena Giraldo (Madrid: ICONA, 1991),110. The argument for the existence of a profuse and specific natural environment, in-depth knowledge of which could only be achieved by involving the natives, was used again on the occasion of the controversy over the cinchona bark monopoly. See, M. A. Puig-Samper, "El oro amargo. La protección de los quinares americanos y los proyectos de estanco de la quina de Nueva Granada," in *El bosque ilustrado,* ed. M. Lucena Giraldo, (Madrid: ICONA, 1991), 235.

forest) are untranslatable. The forest, as has already happened to the Stone of the Sun, becomes a boundary object, and since the botanists had earned the right to uphold their own points of view, the *criollos* had to use their ingenuity to try to appropriate an object that, being an unregistered secular legacy, had been emancipated and mobilized by envoys from the metropolis using technologies transforming a common good into public property.

Common good and patrimony

There are few accounts of the eighteenth century that do not stress the importance of the ideal of technical progress conceived by Enlightenment thinkers. Technology, without doubt, is one of the main protagonists of our world, and its hegemonic deployment is related to some of the processes outlined here.

The two cases studied, ruins and forests, showed themselves to be boundary objects: that is, objects situated (technically and scientifically) at the crossroads between different cultural traditions, sometimes complementary and sometimes competitive. But the important thing, in the final analysis, is to redeem the idea that was emerging at the time that something like the dignity of the Aztecs or the attributes of a species should be a common good, preserved from any threat. What dangers do we mean? First, oblivion and second, abuse.

Let us pause for a moment to look at the form taken by these two threatened realities, shared memory and bio-

logical diversity. We call them realities because, in fact, they came into the collective consciousness when they were emancipated or, in other words, when they were quantified, tabulated and recorded; that is, since we introduced our technologies and their rules of usage and inscription as mediators. And, since we have brought together testimonies that talk of dying off and decadence, we have had to talk of threat, a term that necessarily brings into circulation a whole new group of players, from expert valuers to the officials, delegates and bureaucrats occupied in vigilance, listing and preservation; not to mention the paraphernalia of files, shelves, competetions, commissions, contracts, taxes, valuations or catalogues. In brief: at the same time as the thinkers of the Enlightenment discovered the role of technologies in the formation of consensus they realized the need to convert fragments of reality into a common good. And to guarantee the continuity of the commons and of the consensus, the most acceptable formula they could find was to broaden the public domain to take in the common good. From this arose a collective of experts whose mission was to interweave the threads of the new technologies and the new commons to produce modern forms of fellowship.

From the common good was born a public patrimony, built on manifold commitments interweaving old yearnings for justice and new ideals of austerity. But not every threatened good can be saved by turning it into patrimony. If anyone were to say now that the air we breathe should be a common, he would immediately have to design a chain of laboratories, protocols and norms to define what is healthy air, as well as criteria to improve and protect it. Would the state be the

main manager of these protocols? Does defining something as a public good necessarily turn it into something public? In modern times, since the Enlightenment, the answer is emphatically yes, and only yes. However, today we can admit that the identification of common with public has a date of birth, and perhaps a date of expiry. It came into being because the management of the common good, as was discovered in the eighteenth century, was a profoundly technological undertaking, and only the state was able to absorb the costs and smooth over the controversies.

The state then built on its technological hegemony the highway that connects *common* with the public domain, and created an enormous heritage for all to enjoy. Now we see that knowledge is moving further and further away from the notion of commons and that, moreover, more and more segments of knowledge are unacceptably being privatized, such as traditional learning, software and the genome. And let us state it succinctly: everything that becomes patrimony can change hands, even public hands; to avoid this we urgently need to define new commons, whose maintenance is based on the gift economy, for now the citizen has, for the first time in history, access to the technologies and the resources that would enable us to sustain a range of commons belonging to everybody and to nobody.

CIRCULATION OR (RE)ENACTMENT?

performing the variable virulence/pathogenicity of helicobacter pylori•

By João Arriscado Nunes *

Introduction

This paper has two main objectives. The first is to propose and discuss a framework, inspired by the "agential realist" approach proposed by Karen Barad and by re-readings of recent contributions to the science studies of biology and biomedicine, for dealing with the variable modes of exis-

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tence and enactments, through scientific practices, of biomedical entities. The second objective is to draw on that framework to offer an exploration of the ways in which virulence and pathogenicity (and their variability) have been enacted in research on a specific pathogen, *Helicobacter pylori*.

The choice of this particular topic, and why the proposed framework is regarded as an appropriate way of approaching that topic, requires some explanation. The variability in virulence held a central place in the concerns of early bacteriologists. The concept was crucial for understanding variations in outcomes of infection not only within, but also between populations. The development of effective vaccines, which relied on the capacity to reduce or control the action of the pathogens to be inoculated, was itself dependent on variations in virulence and on the possibility of "taming" it. According to Mendelsohn,

> this almost purely operational concept [virulence] delineated the international landscape of early bacteriology on many levels, intellectual and practical, and in various, even contrary ways. This theoretically emptiest of key concepts was the hub of a theory. Upon it turned a whole structure of etiological, epidemiological, and biological explanation. Together with its counterpart concepts of the host, such as resistance and immunity, differential susceptibility and predisposition (…), variable virulence defined the field of conceivable relations between microorganisms and their hosts, whether in disease or health.[1]

[1] J. Andrew Mendelsohn, "'Like All That Lives': Biology, Medicine and Bacteria in the Age of Pasteur and Koch, *History and Philosophy of the Life Sciences*, 24 (2002): 3-36, on 17-18.

Since the times of Pasteur and Koch, it is not clear at all whether "virulence" has actually overcome its status of "theoretically emptiest of key concepts". Its relevance for etiological, epidemiological and biological explanation of infectious disease, that "complicated revolution within the complex life unit",[2] however, has persisted. The theoretical meanings attached to virulence have come to be understood in relation to its specific enactments in material/discursive procedures, constituted through biological, biomedical and epidemiological practices.

The circulation of pathogens and of the practices through which they are identified and performed as causes of disease, as well as their uses as model organisms, have been major themes in STS approaches to biomedicine and health and in studies in the history of medicine and health, especially those informed by STS.[3] Recent contributions to

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[2] Ludwik Fleck, *Genesis and Development of a Scientific Fact* (Chicago: University of Chicago Press, 1979, 1st ed. 1935), 61.

[3] See, for instance, Bruno Latour, *The Pasteurization of France* (Cambridge, Massachusetts: Harvard University Press, 1988); Mendelsohn, "Biology, Medicine and Bacteria"; Gerald L. Geison, *The Private Science of Louis Pasteur*, (Princeton: Princeton University Press, 1995); Geison, "Organization, Products, and Marketing in Pasteur's Scientific Enterprise, *History and Philosophy of the Life Sciences*, 24 (2002): 37-51; Gerald L.Geison and Manfred D. Laublicher, "The Varied Lives of Organisms: Variation in the Historiography of the Biological Sciences", *Studies in the History and Philosophy of the Biological and Biomedical Sciences*, 32 (2001): 1-29; Wolfgang U. Eckart, "The Colony as Laboratory: German Sleeping Sickness Campaigns in German East Africa and in Togo, 1900-1914", *History and Philosophy of the Life Sciences*, 24 (2002): 69-89; William F. Bynum, "The Evolution of Germs and the Evolution of Disease: Some British Debates, 1870-1900", *History and Philosophy of the Life Sciences*, 24 (2002): 53-68; Michael Worboys, *Spreading Germs: Disease Theories and Medical Practice in Britain, 1865-1900* (Cambridge: Cambridge University Press, 2000); Henrique Cukierman, , *Yes, nós temos Pasteur. Manguinhos, Oswaldo Cruz e a história da ciência no Brasil* (Rio de Janeiro: FAPERJ/Relume Dumará, 2007); Ilana Löwy, *Virus, moustiques et modernité: La fièvre*

STS and "naturalistic" philosophy of science have reinforced the notion, suggested or openly endorsed by some of these studies, that what is at stake in understanding the situated modes of existence of the phenomena biomedicine and the health sciences (and the sciences in general) engage with is how these phenomena arise through specific practices which enact material reconfigurations of the world producing new objects in a diversity of settings, something that the notion of "circulation" fails to capture in an adequate way.[4]

Biomedicine and biomedical research, indeed, offer a particularly interesting field for exploring the ways in which the production of knowledge is entangled with the world, is part of it and generates differences that matter, in the double sense of becoming matters of concern and of reconfiguring the materiality of the world.[5] Following the modes of

jaune au Brésil entre science et politique, (Paris: Éditions des Archives Contemporaines, 2001).

4 Joseph Rouse, *How Scientific Practices Matter: Reclaiming Philosophical Naturalism* (Chicago: University of Chicago Press, 2002); Joseph Rouse, "Barad's Feminist Naturalism", *Hypathia*, 19 (2004): 142-161; Werner Callebaut, *Taking the Naturalistic Turn: How Real Philosophy of Science is Done* (Chicago: University of Chicago Press, 1993).

5 Karen Barad, Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning (Durham, North Carolina: Duke University Press, 2007). See, Annemarie Mol, The Body Multiple: Ontology in Medical Practice (Durham, North Carolina: Duke University Press, 2002) on the performativity of medical practices and on how they make differences that matter. Mol's approach converges in crucial aspects with Barad's "agential realism". For detailed accounts and discussions of the production of biological and biomedical objects and entities as material/discursive or material/semiotic practices, see, Hans-Jörg Rheinberger, Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube, (Stanford: Stanford University Press, 1997); Peter Keating and Alberto Cambrosio, Biomedical Platforms: Realigning the Normal and the Pathological in Late Twentieth-Century Medicine, (Cambridge, Massachusetts: MIT Press, 2003). I return briefly to the convergences as well as to the differences between these approaches in the concluding remarks.

existence of biomedical phenomena and the processes through which they are brought to existence and to make a difference provides a productive approach to an "ontology in movement"[6] which cannot be extricated from knowledge-producing practices and from their accountability as part of a world in ongoing processes of reconfiguration. This paper is an attempt at exploring where these insights may take us through the elucidation of the modes of existence of a bacterium – *Helicobacter pylori* – as it appears in various shapes and associated with different properties in diverse settings. The bacterium is a pathogen generating diverse effects in different places and among different human populations, which are captured by a range of research, clinical and epidemiological practices. The research reported here is part of a broader study of a range of practices and controversies which perform *Helicobacter pylori* (H.p.) as a biomedical entity and *Helicobacter pylori* infection as a phenomenon, through the mutual definition of the boundaries of health and disease, pathogens and human actors, instruments and biomedical entities.

These practices include those which enact H.p. as an epistemic object[7] – an object which, even when stabilized and mobilized in further experimental or observational practices, is (re)enacted to search for new differences[8] –, as an established biomedical fact, and as a genetically diverse

6 Lorraine Daston, "Introduction: The coming into being of scientific objects", in *Biographies of Scientific Objects*, ed. L. Daston (Chicago: University of Chicago Press, 2000), 1-14.

7 Rheinberger, Toward a History of Epistemic Things.

8 Rouse, How Scientific Practices Matter.

organism associated with variable clinical and epidemiological outcomes.

The approach taken here is based on the conception of variable virulence/pathogenicity (the two terms will be used interchangeably throughout this paper) as a *phenomenon* – an active reconfiguration of the world that confers intelligibility to a localized situation – enacted through practices constitutive of *apparatuses*, which are productive of the boundaries or "cuts" that differentiate *objects* (such as multiple strains of H.p. or virulence-associated genes) from *agencies of observation*. This approach is inspired by recent work by Joseph Rouse and Karen Barad, and by re-readings of recent contributions to the social studies of biology and biomedicine, including those by Mol; Keating and Cambrosio; and Rheinberger, among others.[9]

The first section of the paper offers a more detailed presentation of the approach, and is followed by a summary of the history of the emergence and diverse enactments of *Helicobacter pylori* as a biomedical entity. The third section provides an account of the enactment of variable virulence/pathogenicity through specific biological and biomedical practices. The final section discusses some of the implications of this work for the reconfiguration of approaches to the enactment/performance of biomedical phenomena.

9 Rouse, How Scientific Practices Matter; Barad, Meeting the Universe Halfway; Mol, The Body Multiple; Keating and Cambrosio, Biomedical Platforms; Rheinberger, Toward a History of Epistemic Things.

The approach

The approach proposed in this paper draws on the recent work of Karen Barad and Joseph Rouse.[10] According to these authors, the objective referent of knowledge-producing practices is not an independent external world, but *phenomena*. A phenomenon may be defined as a "reproducible local material arrangement or `set-up´", such as "experimental arrangements or observational configurations".[11] "Reproducible" should not be understood as being characterized by actual repetition or regularity, but rather by *repeatability*: "what matters is not the exact reproduction of the same sequence of events, but the reproduction of a signifycant pattern despite various differences among instances of the same phenomenon. To repeat an experiment, for example, is not to do the same thing exactly, but to try to produce the same pattern in different circumstances, and perhaps by somewhat different means".[12]

Barad draws on what she describes as Niels Bohr's philosophy-physics to provide working definitions of what phenomena are. According to Bohr, the term should be applied "exclusively to refer to the observations obtained

[10] My use of the work of these and other authors takes the form of what Haraway and Barad call a "diffractive" reading of a range of contributions to STS and "naturalistic" philosophy of science. Diffraction (in contrast to reflection) allows for patterns of difference to emerge through the entanglement of readings, rather than just mirroring or juxtaposing readings. I shall come back to this point in the final section of the paper. Donna J. Haraway, Modest_Witness@Second_Millenium.FemaleMan ©_Meets_OncoMouse™: Feminism and Technoscience, (New York: Routledge, 1997); Barad, Meeting the Universe Halfway (cit. n.5).

[11] Rouse, "Barad's Feminist Naturalism" (cit. n. 4), 146.

[12] Rouse, "Barad's Feminist Naturalism", 147.

under specified circumstances, including an account of the whole experimental arrangement".[13] Barad extends and reconfigures Bohr's conception in the following way:

[P]henomena are the *ontological inseparability of intra-acting agencies* (...), not the mere result of laboratory exercises engineered by human subjects but *differential patterns of mattering* ("diffraction patterns") produced through complex agential intra-actions of multiple material-discursive practices or apparatuses of bodily production.[14]

Phenomena are thus "material configurations of the world, which are frequently, but not exclusively the product of scientific research".[15]

But phenomena also appear as material configurations of the world in so far as they "constitute a practical or `constructed´ cut between a measuring apparatus and a measured `object´.[16] No inherent boundary divides and object from its surroundings, for the location of the cut depends upon the configuration of the apparatus".[17]

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13 Quoted in Barad, *Meeting the Universe Halfway* (cit. n.5), 119.

14 Quoted in Barad, *Meeting the Universe Halfway* (cit. n.5), 206 (Italics in original).The "agential realist" framework proposed by Barad starts from the premise that relations are always prior to the relata, which are the outcomes of specific "cuts" or boundaries performed through practices and the apparatuses these practices are constitutive of. Relations are thus not made of interactions between entities existing prior to the phenomenon being considered: "A phenomenon is a specific intra-action of an `object´ and the `measuring agencies´; the object and the measuring agencies emerge from, rather than precede, the intra-action that produces them". Barad, *Meeting the Universe Halfway,* 128. For a more detailed treatment of this point, see especially Chapters 3 and 4.

15 Rouse, "Barad's Feminist Naturalism" (cit. n. 4), 147.

16 Measurement should be understood here in a broad sense, encompassing different practices allowing "causes" and "effects" to be established. Different observational or experimental "dispositifs" would be included under this broad definition.

17 Rouse, "Barad's Feminist Naturalism" (cit. n. 4), 148.

Apparatuses, in turn,

> are not preexisting of fixed entities; they are themselves constituted through particular practices that are perpetually open to rearrangements, rearticulations, and other reworkings. This is part of the creativity and difficulty of doing science: getting the instrumentation to work in a particular way for a particular purpose (which is always open to the possibility of being changed during the experiment as different insights are gained).[18]

Within this framework, concepts are meaningful only by reference to specific *material/ discursive apparatuses* which are, at the same time, phenomena and productive of phenomena. Pathogens, hosts, multiple strains of bacteria or virulence-associated genes are thus defined by reference to the apparatus that constitutes them through a "cut" between object and agencies of observation. Human actors and their agency cannot be defined separately from accounts of apparatuses and of the practices that are constitutive of the latter, either.

Rather than conceiving of objects and "agencies of observation" as coming together or interacting through specific assemblages or practices, this approach requires that they be treated as being constituted through processes of "cutting", differentiating or boundary-setting, as part of phenomena and of the situated constitution of patterns of intelligibility through the operation of specific apparatuses and of the intra-actions of these.[19] Apparatuses should thus not

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[18] Barad, Meeting the Universe Halfway (cit. n.5), 203

[19] See Barad, Meeting the Universe Halfway (cit. n.5), for a fuller discussion of these points. Readers familiar with the work of Rheinberger Toward a History of Epistemic Things (cit. n. 5), and Keating and Cambrosio, Biomedical Platforms (cit. n. 5), will notice that the experimental systems of the former or the latter's biomedical platforms may be

be equated with assemblages of humans and non-humans. They may (but must not) include humans, but it is through the working of the apparatus itself that the boundaries of humans and non-humans are established.[20]

Within this framework, virulence/pathogenicity may be defined as the outcome of a set of material-discursive practices constitutive of apparatuses, producing through their intra-actions the cuts between objects and agencies of observation or experimentation, and generating phenomena such as H.p. strains, virulence-associated genes, clinical outcomes of H.p. infection or epidemiological outcomes.

An implication of this approach, which cannot be pursued in detail here but is of particular importance for the field of medicine and health, is that, as active participants in the material reconfiguring of the world, human actors are accountable for all the consequences and effects arising from their agency. The practices of biological and biomedical researchers, epidemiologists and clinicians are accountable to a world inhabited by human and non-human agencies, whose existence is always the consequence of intra-actions they are a part of. This view, associated with current discussions within feminist science studies and feminist philosophy, provides interesting extensions and reinterpretations of pragmatist contributions to the philosophy of science, as well as of some recent contributions to the social studies of medicine and health. More generally, it points towards the

redescribed as measuring apparatuses as defined by Barad. Again, a fuller discussion of this topic is beyond the scope of this paper and will be the object of a detailed treatment in forthcoming work by the author.

20 Barad, *Meeting the Universe Halfway* (cit. n.5), 171-172 and note 434.

ongoing attempts at a reconfiguration of the relationships between ethics, epistemology and ontology, again understood not as separate domains which should be brought together, but rather as the outcomes of specific operations of differentiation and boundary-creation.[21]

The analysis of the apparatuses and practices constitutive of the phenomenon of the variable virulence/pathogenicity of H.p. is based on a close reading of a series of published papers and, in particular, of their "Materials and Methods" sections, complemented by interviews with researchers and materials from ethnographic work in a research laboratory. In spite of the criticisms often addressed in the STS literature to the inadequacy of published papers as accounts of scientific practices, the use of these materials as the main sources for the analysis that follows derives from the way they provide detailed descriptions of apparatuses and of the practices that are constitutive of them. These descriptions allow the production of traces and effects, making the process of moving from "naming actions" to "naming things" traceable[22] and displaying its performative quality.[23] In the terms of the framework adopted here, this movement

[21] For discussions of these points, see Barad, *Meeting the Universe Halfway* (cit. n.5), especially Chapter 8 (pp. 353-396); and Rouse "Barad's Feminist Naturalism" (cit. n. 4), 154-156.

[22] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies*, (Cambridge, Massachusetts: Harvard University Press, 1999), 119-120; João Arriscado Nunes, "Do `nome das acções´ ao `nome das coisas´: crenças e produção de objectos epistémicos nas ciências da vida e na biomedicina", in *O processo da crença,* ed. Fernando Gil, Pierre Livet and João Pina Cabral (Lisbon: Gradiva, 2004), 402-412.

[23] Barad, *Meeting the Universe Halfway* (cit. n.5); Rouse "Barad's Feminist Naturalism" (cit. n. 4), 151. On the convergences and differences between this approach and actor-network theory, see the concluding remarks.

would correspond to the intra-active process whereby "actions" produce the material/semiotic boundaries differentiating "objects" and "agencies of observation".

The papers I have drawn upon were published between 1998 and 2000 and brought together as the doctoral dissertation of their main author, submitted in 2000.[24] Additional materials included other papers quoted in these publications, an interview with their main author and ethnographic materials from two studies of the laboratory where most of that work was performed, which were carried out between 1994 and 2002, with field visits over the following years.

Limitations of space do not allow a detailed account of all the practices through which the variable virulence/ pathogenicity of H.p. is enacted as a phenomenon, nor of the range of apparatuses involved. I have thus opted for a detailed rendering of one of these practices/apparatuses and a more general discussion of how the whole project which, for the purposes of this paper, is equated with the work reported

[24] Céu Figueiredo, vacA, cagA *and* iceA *Genes of* Helicobacter pylori*: Genotyping, Epidemiology and Clinical Relevance*, Doctoral Dissertation, School of Medicine, University of Oporto, 2000; Céu Figueiredo et al, "Genetic organization and heterogeneity of the *iceA* locus of *Helicobacter pylori*," *Gene*, 246 (2000): 59-68. L.J van Doorn,. et al, "Typing of *Helicobacter* pylori vacA gene and detection of cagA gene by PCR and reverse hybridisation", Journal of Clinical Microbiology, 36 (1998): 1271-1276; L.J. van Doorn et al, "Expanding allelic diversity of Helicobacter pylori vacA", Journal of Clinical Microbiology, 36 (1998): 2597-2603; L. J. van Doorn et al, Clinical relevance of the cagA, vacA and iceA status of Helicobacter pylori, Gastroenterology, 115 (1998): 58-66; L. J van Doorn et al, "Distinct variants of Helicobacter pylori cagA are associated with vacA subtypes", Journal of Clinical Microbiology, 37 (1999): 2306-2311; L. J. van Doorn, et al, "Geographic distribution of vacA allelic types of Helicobacter pylori", Gastroenterology, 116 (1999): 823-830. All quotations are from the versions included in Figueiredo, Genotyping, Epidemiology and Clinical Relevance.

in the papers I have analysed, may itself be approached as a phenomenon.

But first, let us look briefly at the making of *Helicobacter pylori* as a biomedical entity and as a pathogen.

Helicobacter pylori: a short biography

In 1982, two Australians, the pathologist Robin Warren and the physician Barry Marshall, successfully cultured bacteria from gastric biopsies. The results of their work were first published in 1984, after several unsuccessful attempts. Although bacteria had been reported to be found in the gastric region of several non-human animals and in humans since the late 19th Century, colonization by bacteria of the gastric region was generally regarded by gastroenterologists as an impossibility, due to the inhospitable environment which, through secreted acids, allegedly kept the stomach sterile.[25] Warren and Marshall, however, found a strong association between two kinds of peptic ulcers and what seemed to be infection by a bacterium. After a struggle for having their views put to the test, Warren and Marshall were finally vindicated, thus turning an implausible or impossible entity into a central actor in gastric pathology. This required the development of different research lines, involving several specialties in biomedicine, including gastroenterology and microbiology. Identified at first as a strain of an

[25] See the contributions included in Barry Marshall (ed.), *Helicobacter Pioneers: Firsthand Accounts from the Scientists who Discovered Helicobacters*, (Carlton House: Blackwell Publishing, 2002).

already known bacterium, *Campylobacter*, and christened accordingly *Campylobacter pyloridis* and later *Campylobacter pylori*, the new bacterium would finally be recognized as an altogether different genus and renamed *Helicobacter pylori* (H.p.) in 1989.[26]

Over the decade following its successful culture, H.p. would become the subject of an increasing number of publications (Figure 1) in a diversity of journals aimed at different specialties in biomedicine and originating in a range of countries form both North and South (with a clear dominance, however, of publications form the North).

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	**Total**
3	15	94	208	374	376	324	569	564	971	1052	1403	**5953**

Figure 1. Publications on *Helicobacter pylori*, 1984-1995 (Source: ISI, Science Citation Index)

[26] C. S. Goodwin, "How *Helicobacter pylori* acquired its name, and how it overcomes gastric defense mechanisms", *Journal of Gastroenterology and Hepatology*, 9 (Supplement 1) (1994): S1-S3. Marshall has recently edited a volume including a number of contributions on work which, according to the reconstruction proposed by the very organization of the book, opened up the path to the identification and characterization of H.p. (Marshall, *Helicobacter Pioneers*). For an useful overview of the setting and chronology of early work on *Helicobacter pylori*, see Paul Thagard, "Ulcers and bacteria I: Discovery and acceptance", *Studies in History and Philosophy of Science, Part C, Studies in History and Philosophy of Biology and Biomedical Sciences*, 29 (1998): 107-136; Paul Thagard, "Ulcers and bacteria II: Instruments, experiments, and social interactions", *Studies in History and Philosophy of Science, Part C, Studies in History and Philosophy of Biology and Biomedical Sciences*, 29 (1998): 317-342; Paul Thagard, *How Scientists Explain Disease* (Princeton, New Jersey: Princeton University Press, 1999). Beyond more general disagreements on Thagard's epistemological and theoretical commitments and on his treatment of science studies, this work and the broader project it is part of differs from Thagard's in one very important respect: its aim is not to provide a general argument on how scientists explain disease through a particular case study, but to

In 1991, four different studies established a relationship between infection by H.p. and gastric carcinoma. Further evidence on the latter led the International Agency for Research on Cancer to declare H.p. a class I (the most dangerous type) carcinogen in 1994.

By that time, H.p. had been recognized as a key factor in many gastric diseases. A major event in the path towards this recognition was the 1994 NIH Consensus Conference. On that same year, a group of specialists in gastric pathology met to update the guidelines for the diagnosis and prognosis of gastritis, stressing the central role of H.p. in most forms of chronic gastritis and associated gastroduodenal diseases:

> The discovery of *Helicobacter pylori* totally altered our concepts of etiology, as it has become apparent that infection with this organism is the major cause of nonautoimmune chronic gastritis. Furthermore, investigations of gastritis prompted by the discovery of *H. pylori* have led to the recognition of other distinctive forms, such as lymphocytic and reflux gastritis.[27]

These guidelines, known as the Updated Sidney System, were published in *The American Journal of Surgical Pathology* in 1996, and have become an obligatory point of passage [28] for clinicians and clinical researchers. In 1997, the first Maastricht Consensus Report established further guidelines for the management of H.p. infection. By

follow the ways in which a specific biomedical entity is performed through a range of situated practices and their narrative reconstructions.

[27] M.F. Dixon et al, "Classification and Grading of gastritis: the Updated Sydney System", *The American Journal of Surgical Pathology*, 20 (1996): 1161-1181, on 1161.

[28] Bruno Latour, *Science in Action*, (Milton Keynes: Open University Press, 1987).

the mid-1990's, and in spite of some influential but minority dissenting voices, H.p. was well-established as a central actor in gastric pathologies. Its association, as shown by epidemiological studies, with chronic gastritis, peptic ulcer and gastric carcinoma, was regarded by most researchers and clinicians in the area as a settled question, and treatment of infection by H.p. had been successfully managed through the use of antibiotics. In 1997, *Nature* published the first complete sequence of the genome of two strains of H.p..[29] This was followed by a plethora of studies on the variety of strains of H.p. and on their respective genotypes. The latter is seen by researchers as a crucial step towards more effective strategies for the treatment of infection.

In July 2005, Robin Warren and Barry Marshall were awarded the Nobel Prize for Medicine or Physiology for their work on the associations between infection by *Helicobacter Pylori*, and common gastric diseases, such as peptic ulcer disease or chronic gastritis, as well as its role as a precondition of gastric cancer.

One of the most relevant consequences of the emergence of the new pathogen was the recognition of H.p. infection as a major health problem affecting populations in different regions of the world, more severely in Southern Europe, Africa, Asia and Latin America. Epidemiological and clinical work demonstrated how widespread infection by H.p. was in these different regions. But it also displayed a considerable range of differences in the clinical and epide-

[29] J.F. Tomb et al, "The complete genome sequence of the gastric pathogen Helicobacter pylori", *Nature*, 388 (1997): 539-547.

miological outcomes of infection by H.p. and in their geographical distribution. Throughout the 1990s, further research showed that these differences were associated with a variety of strains of the bacterium, identifiable though their diverse genotypes, and with the variable virulence of these strains.

In spite of the portrayal of H.p. as the villain in stories of gastric disease, researchers face many uncertainties as far as the question of the pathogenicity of H.p. is concerned. In fact, whereas infection with H.p. is common among different populations (even if the prevalence of the infection may vary between ca. 50% and ca. 90% depending on the region), not all carriers of the bacterium are symptomatic, and only a fraction of them end up developing serious conditions of the gastric tract. The variable pathogenicity of H.p. – a notion used interchangeably with that of variable virulence – is thus not an intrinsic property of H.p. Being infected with H.p. does not necessarily mean that symptoms of dyspepsia, gastritis or peptic ulcer disease will appear, or that those infected will be invariably at risk of developing gastric cancer or MALT lymphoma. The problem for researchers, clinicians and public health officials is neatly summarized in the following passage:

> *H.pylori* has probably been part of the normal microbial flora of humans since ancient times (...). If we assume that colonization has occurred over a long time, it is plausible that the bacterium has since adapted to fit its ecological niche in the gastric mucosa. This may have developed into symbiosis of bacterium and host, and thus *H. pylori* and the human host exist in a dynamic equilibrium, microorganisms and host signaling each other (...). Disruption of this equilibrium may influence processes such as epithelial cell proliferation and apoptosis, gastric acid secretion, and lym-

> phoid proliferation. At present, it is unknown which factors determine development of disease, and many patients remain asymptomatic, despite persistent colonization by *H. pylori*. However, these processes are multifactorial and extremely complex, involving bacterial virulence factors, host factors and environmental conditions. Each will play a role, but the relevance of individual factors as well as their interaction is not clear at present.[30]

The action of H.p. as a pathogen thus depends, according to this view, on three kinds of "multifactorial and extremely complex processes": "bacterial virulence factors", "host factors" and “environmental conditions". The outcome of the intersection of these processes is not always the development of disease, since asymptomatic patients infected with H.p. are common. Notions like "symbiosis" and "dynamic equilibrium", and explicit reference to the way the bacterium "fits" its "ecological niche" in the gastric mucosa hint at the existence of "normal" or non-pathological relationships between bacteria and host.

Further difficulties arise in relation with the need to identify the sources of variable virulence (or pathogenicity) of the bacterium. Is it an outcome of the variability of bacterial strains? Or does it arise from the relationships between infection with specific bacterial strains, host susceptibility and environment (such as conditions of access to sewage and clean water, for instance)? The problem was compounded, first, by the emergence, among different populations, of increased resistance to treatments aiming at the eradication of H.p. which had been widely used since the early 1990s,

[30] Figueiredo, Genotyping, Epidemiology and Clinical Relevance (cit. n. 25), 205.

with success rates of the order of 90%. This problem has been associated with strains which have developed resistance to some of the antibiotics used in these treatments. Other complications entered the picture as the flipside of successful eradication became apparent. Whereas the predictable relationship between eradication of H.p. and the decrease of pathologies like peptic ulcer and non-cardia gastric cancers has been confirmed, other diseases, like gastroesophageal reflux, Barrett's esophagus, adenocarcinoma of the lower esophagus or gastric cardia have increased "dramatically and progressively". Some of the strains of H.p., as suggested by a number of studies, may well offer some protection against the latter diseases, even if the same strains are "associated with a higher risk for diseases of the lower stomach" (Figueiredo, 2000: 206).[31] This raises the possibility that

> [b]y eliminating H. pylori to reduce risk in one group of diseases, the risk for others could be increasing. It can even be hypothesized that *H. pylori* might have other beneficial features for the host, not apparent today.[32]

The variability of clinical outcomes of H.p. infection and of H.p. eradication thus brought to the centre of the concerns of researchers and clinicians the need to understand the sources of the variable pathogenicity of the bacterium. As stated earlier, this prompted research into the variability of bacterial strains and their association with what researchers

[31] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 206.
[32] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 206

defined as host-susceptibility and environmental factors. Rather than defining virulence or pathogenicity as an attribute of bacteria, researchers set up a range of experimental and observational apparatuses which would allow virulence/pathogenicity to be enacted as phenomena.

Enacting virulence

Let us turn now to a more detailed examination of how "virulence" and "pathogenicity" (used by researchers as interchangeable terms) are enacted through specific research and clinical practices, and how they have become key aspects in the explanation of the diversity of clinical and epidemiological outcomes of H.p. infection within and between populations in different regions of the world.

Throughout the second half of the 1990s, H.p. was progressively redefined as a "worldwide population of bacterial variants, which may have different clinical impact in different parts of the globe", rather than being regarded as "a single infectious organism".[33] Host susceptibility, in turn, focused in more detail on the identification of human polymorphisms associated with mucins, the IL-1 cytosin, blood groups and the HLA system.

By the late 1990's, an important focus of research was the elucidation of the molecular structure of genes associated with virulence in different strains of H.p. and of their epide-

[33] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 171.

miological and clinical significance, which proceeded along three main lines:

- the development of methods (molecular biological and serological) for typing H.p. strains;
- the mapping and analysis of the distribution of H.p. strains across the world, their associations and relationships with epidemiological data on gastric diseases;
- the assessment of the clinical relevance of genotypes of H.p., drawing on a range of molecular biological, serological and epidemiological procedures.

Different apparatuses were available for the task of redefining H.p. as a variety of strains characterized by their genotypes and serological profiles and associated with variable clinical and epidemiological outcomes. These apparatuses include endoscopical observation of patients and sampling of biopsy material; provision of tissue samples from patients through surgical procedures; histological procedures; DNA isolation/extraction; RAPD (Random Amplification of Polymorphic DNA, also known as PCR fingerprinting), PFGE (Pulsed-Field Gel Electrophoresis), RFLP (Restriction Fragment Length Polymorphism), PCR-reverse hybridization, based on the Line Probe Assay principle; several assays used for serological analysis; and statistical analysis of data.

A number of differences between genotypes were thus identified, such as variation of gene order or variable presence of plasmids. The mechanisms underlying the diversity

of strains, including point mutation, transformation and recombination were also investigated. But the main interest of researchers was the search for genetic markers of the differential degree of virulence of different strains. Whereas genotypical characteristics can be identified through gene sequencing techniques, "virulence" cannot be performed by resorting to any single apparatus mobilized in biomedical and biological research, or in clinical or epidemiological practices. The definition of "virulence", in fact, is the outcome of a set of phenomena produced through a range of apparatuses. This involves, first, taking biopsies or other biological materials from both patients with gastric diseases associated with H.p. infection and healthy individuals. Next, bacteria are genotyped and different strains characterized. It is only after genotyping that specific genes and their allelic variants can be identified and later associated with the presence of infection in patients. The characterization of specific genes defined as virulence-associated genes is a material/discursive construction, which requires the genotyping of the bacterial strains infecting diseased patients and the identification of their allelic variants associated with infection:

> Since not all *H. pylori* infections result in the development of disease, considerable effort has been taken to identify genetic markers for the degree of virulence of different strains. This has resulted in the identification of several virulence-associated genes, which (the genes or one of their specific allelic variants) are often present in *H. pylori* strains isolated from patients with disease, but are mostly absent in strains from healthy individuals. Thus, the term

> virulence-associated genes is largely based on clinical and epidemiological observations".[34]

The virulence-associated genes thus identified include the following:

- *vacA*, which encodes a toxin damaging epithelial cells through the formation of vacuoles; a distinction is made between *s* and *m* regions of the gene, based on allelic variation, allowing the identification of several types and subtypes;
- *cagA*, a gene whose presence is considered a marker of a *pathogenicity island*, a multigenic region associated with virulence;
- *iceA*, induced by contact with the epithelium; there are two allelic variants, but their function is not clear;
- *babA*, which is associated with binding to blood-group antigens; two allelic variants are known.[35]

Each of these genes is thus linked to specific effects on cells (effect of a cytotoxin through formation of vacuoles that damage epithelial cells; induction by contact with epithelium; binding to blood-group antigens…). For the purpose of enacting variable virulence or pathogenicity, multiple strains are identified through their genotypes and these, in turn, through the presence or absence of specific allelic variants of the genes of interest.

[34] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 23.
[35] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 23-25.

Finally, the distribution of strains defined by specific genotypes is characterized through epidemiological studies. In fact, the expression "virulence-associated genes" is "largely based on clinical and epidemiological observations".[36] "Virulence" emerges from the practices which actively produce the boundaries between bacteria and hosts or of bacterial strains of variable infective capacity.

The external boundaries of a phenomenon are not defined once and for all. They are established through the intra-actions constitutive of the material/discursive practices associated with each apparatus or the intra-actions of apparatuses that produce local intelligibility. Patients may thus be considered as part of the phenomenon of genotyping, in so far as bacteria are obtained from biological materials, such as biopsies, taken from patients. Similarly, the definition of the strains of interest and of the appropriate methods for genotyping are closely linked to the identification of clinical effects and to the epidemiological distribution of infection and related pathologies. Tables, charts and maps are drawn to enact "virulence" and "virulence-associated genes" as objects of scientific work and discussion, through practices constitutive of the entangled apparatuses of biomedicine.

Apparatuses: PCR-reverse hybridization-LiPA

PCR-reverse hybridization-LiPA is a procedure favoured by researchers to enact H.p. genotypes and virulence-

[36] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 23.

associated genes, and we shall examine it in some detail here. It is based on "the simultaneous amplification of multiple genomic fragments" and is "particularly suitable for standardized epidemiological studies". Its high sensitivity to "simultaneous detection of multiple strains" makes it an appropriate technique for dealing with instances of co-colonization of a patient's gastric mucosa by different strains of H.p.[37] It is noteworthy that this technique is recommended by researchers because of its appropriateness for clinical and epidemiological studies, and not simply for its reliability or efficiency as a molecular biological tool. Its use made it possible to work directly on biopsies, thus avoiding the effects of selection of microorganisms associated with bacterial cultures (Interview with researcher).[38]

PCR-reverse hybridization is described as a “method … based on the simultaneous amplification of multiple genomic fragments”, and using non-specific PCR primers, “aimed at conserved sequences, flanking polymorphic regions of interest”.[39] The fragments thus obtained, after amplification,

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[37] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 28.

[38] This particular apparatus thus displays features of what Keating and Cambrosio, *Biomedical Platforms* (cit. n. 5), define as a biomedical platform. See the last section for further discussion.

[39] PCR (Polymerase Chain Reaction) is a technique developed during the 1980s for amplifying (making copies of) particular DNA sequences, which has become a routine procedure in molecular biology and forensic laboratories. A primer is a “short, preexisting polynucleotide chain to which new deoxyribonucleotides [DNA] can be added by DNA polymerase”, an “enzyme that effects the replication of the DNA fragment between the two primers on the ends”. Daniel J Kevles and Leroy Hood, eds., *The Code of Codes: Scientific and Social Issues in the Human Genome Project* (Cambridge, Massachusetts: Harvard University Press, 1992). On the invention and development of PCR, see Paul Rabinow, *Making PCR: A Story of Biotechnology*, (Chicago: University of Chicago Press, 1996).

are analyzed through an assay known as LiPA (Reverse hybridization-Line Probe Assay), performed in one step:

> This assay comprises a nitrocellulose strip, carrying oligonucleotide probes, which are immobilized as parallel lines. The design of the probes permits highly specific hybridization of PCR fragments under stringent conditions. Consequently, reverse hybridization allows detection of single nucleotide mismatches between probe and PCR fragment. This method is easy to use, since it requires only one PCR and a single hybridization step to obtain a multiple parameter result.[40]

Through the performance of LiPA, particular marks are left on a body – defined in a broad sense, as Barad suggests –, in this case a nitrocellulose strip, which are one with the materialization of a phenomenon, variable genotypes of H.p. PCR-LiPA, is "particularly suitable for standardized epidemiological studies", since it allows the genotyping of large numbers of isolates, and its high sensitivity makes it an important procedure for the identification of situations of co-colonization by different genotypes through the simultaneous detection of multiple strains. This is the case even when these different genotypes account only for a small part of the bacteria infecting the patient.[41]

PCR-LiPA as an apparatus is composed of a PCR device; non-specific primers; DNA fragments from bacteria, obtained from specimens of biopsies or surgically removed tissue from patients; a nitrocellulose strip carrying oligonucleotide probes; a human agent operating PCR and performing the assay; laboratory equipment for the performance of

[40] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 28.
[41] Figueiredo, Genotyping, Epidemiology and Clinical Relevance, 28.

the assay. The procedure generates a differentiation/boundary between object – genotypes of H.p. – and observational agency – instruments, materials, human operators. The boundaries of the phenomenon, however, are not defined once and for all. One could include in it the patients providing the biological materials; the different materials, instruments and humans that intra-act in practices such as surgical procedures, endoscopies and biopsy sampling, histological examinations, DNA isolation and extraction. Different spaces could be include here as well, from the operating rooms to the lab benches where histological procedures, DNA extraction and processing are performed, as well as computers, statistical software packages, maps and other inscription devices for accounting for clinical and epidemiological outcomes.

Let us go back for a moment to PCR-LiPA: which "differences that matter" are established through the intra-actions constituting this apparatus, thus giving rise to new objects? Again, we should not forget that there is no intrinsic distinction between object and phenomenon. It is through the performance of PCR and the use of a set of primers aimed at the regions of interest in the bacterial genome that specific genes are "detected" ("cut" from other genomic material) and amplified for further analysis.

LiPA performs a further differentiation, through the enactment of what researchers describe as the "mosaic struc-

ture" of the genes, making available for analysis variable alleles, the cut performing now these genes as objects.[42]

Virulence-associated genes are thus defined through a specific "cut" between object and agencies of observation/experimentation, performed through an apparatus. Objects are recognizable through the marks that are left on their surroundings by the intra-actions constitutive of the apparatus, as Barad and Rouse notice. These marks become, in turn, a measuring apparatus, measuring not some property of the object itself, but of the phenomenon the object is part of. The measurement or, more generally, the evaluation of virulence or pathogenicity can thus be carried out through specific effects of the object (in this case virulence-associated genes) on devices such as a nitrocellulose strip carrying oligonucleotide probes.

Concluding remarks

The framework presented and discussed in this paper is intended as a contribution to the ongoing efforts at the reconfiguration of approaches to the modes of existence of biological and biomedical entities and to how they are enacted as objects of knowledge and as entities making a difference in the world, a "difference that matters". It is intended to be a response to the call by Lorraine Daston and other scholars in science studies for an "ontology in motion… an

[42] For detailed information on the sequence of operations and materials involved and a description of the results, see Figueiredo, *Genotyping, Epidemiology and Clinical Relevance*, 47-50, 62-63, 69, 79-80, 148-149.

ontology that is true to objects that are at once true and historical".[43] This approach is heavily indebted to the framework of "agential realism" and to the reconstruction of "naturalistic" approaches to science studies and to the philosophy of science proposed, respectively, by feminist physicist/science studies scholar Karen Barad and by philosopher Joseph Rouse. Following Barad's lead, I have engaged in a "diffractive" way with their work. This "diffractive" reading included a wide range of contributions to the STS literature (and, in particular, to the literature on the social studies of medicine and health), as well as the biological and biomedical literature which provided the main sources for the work reported on in the previous section. In these concluding remarks, I would like to engage more explicitly with some of these contributions.

Let me briefly recall, at this point, that reading "diffractively", rather than "reflexively", entails an active engagement which excludes treating texts as reified entities, thus allowing for patterns of difference to emerge though the entanglement of readings, rather than just mirroring or juxtaposing them.

Readers familiar with the different brands of actor-network theory (ANT) will recognize some themes common to ANT and to the approach inspired by Barad and Rouse which was presented and discussed in this paper. Both approaches display a concern with following or tracing the practices that constitute (depending on the approach), a specific assemblage or apparatus productive of phenomena

43 Daston, "The coming into being of scientific objects" (cit. n. 6), 14.

and of intelligibility. But whereas most versions of ANT start from the acknowledgement of the heterogeneity of the world and describe the constitution of the collective agencies they call actor-networks as operations of making and unmaking attachments, Barad's agential realist approach treats heterogeneity as the outcome of the practices constitutive of reconfigurations of the world. It should be noted, however, that recent attempts at thinking through the ontological implications of ANT by drawing upon pragmatist philosophy and, in particular, William James's work, resonate strongly with Barad's agential realism (Latour, 2007).[44] Readers will recognize some at least some "family resemblances" of this framework with Annemarie Mol's performative approach to medical practices and to "ontological politics", with Hans-Jörg Rheinberger's account of experimental systems and the performance of epistemic objects, or with Peter Keating and Alberto Cambrosio's concept of "biomedical platforms", to mention only some of those contributions which were particularly relevant for the topic of this paper.[45]

There is, first, a strong resonance of the framework proposed here with Mol's approach to medical practices as performative of bodies, knowledges and conditions which have effects marked upon the bodies of patients and make a difference in the world. The "tactics" through which these

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44 Bruno Latour, "La connaissance est-elle un mode d'existence? Rencontre au museum de james, Fleck et Whitehead avec des fossiles de chevaux," in Vie et expérimentation. Peirce, James, Dewey, ed. Didier Debaise, (Paris: Vrin, 2007), 17-43.

45 Mol, *The Body Multiple,* (cit. n. 5); Rheinberger, *Toward a History of Epistemic Things* (cit. n. 5); Keating and Cambrosio, *Biomedical Platforms* (cit. n. 5).

different enactments of or performances are made to cohere and thus avoid fragmentation are very close to what Barad describes as the entanglement of different apparatuses, each of them generating different "cuts" between objects and agencies of observation. The phenomenon of atherosclerosis as a medical condition – to take the case studied by Mol – is thus the outcome of this entanglement. The notion of "ontological politics", in turn, as a shorthand for the performativity of medical practices and the differences they make, is a significant resource for thinking through the proposal of an ethico-onto-epistemo-logical reconfiguration called for by Barad.

Keating and Cambrosio, in turn, define biomedical platforms as "material and discursive arrangements that act as the bench upon which conventions concerning the biological or normal are connected with conventions concerning the pathological".[46] Platforms allow for the coordination of practices and for specific arrangements of instruments and programs. This concept provides, on the one hand, an useful tool for the exploration of how intra-actions of apparatuses are productive of biomedical phenomena; on the other hand, however, it seems to oscillate between the conception of platforms as being based on the intersection, interdependence or cooperation of heterogeneous actors, materials, instruments and conventions and the conception that, rather than the meeting of entities and actors inhabiting separate social worlds, "empirically speaking, they are in the same room"[47]:

46 Keating and Cambrosio, Biomedical Platforms (cit. n. 5), 332.
47 Keating and Cambrosio, *Biomedical Platforms* (cit. n. 5), 332

in other words, it is the platform that defines these entities and actors through the specific differentiations and boundaries it enacts. The second conception is closest to Barad's and Rouse's notion of intra-actions (not interactions) as constitutive of apparatuses, phenomena, objects and agencies of observation. Keating and Cambrosio's concern with regulation as a constitutive feature of biomedical platforms provide as well an empirically-grounded point of entry to the discussion of how to reconsider the specific configurations of ethics, ontology and epistemology arising from scientific practices.

Rheinberger's account of experimental systems and epistemic or technical objects also resonates strongly with Barad's and Rouse's contributions. Experimental systems may be redescribed both as phenomena and as specific instances of apparatuses, productive of certain types of objects (epistemic objects) and of agencies of observation. Rheinberger's stabilized, technical objects become, in this view, part of the agencies of observation as an effect of the "cut" established by the practices constitutive of the apparatus.

Further mutual engagement (or "intra-action") of these different lines of work through diffractive readings provides significant opportunities for a productive reconfiguration of STS or STS-informed research on the diversity of both scientific practices and of the phenomena and objects they enact. This paper has sought to offer an exploration of how time-honoured topics of both biological and biomedical research and of science studies may be approached through these reconfigurations.

Rationalizing maintenance activities within French industry during the *Trente Glorieuses*[*] (1945-75)

By Konstantinos Chatzis [**]

Introduction

Although historians have already expressed a lot of interest in the rationalization process within the French industry, it is clear that up to the present the subject has been dealt with selectively. While historical analyses concerning rationalization during the inter-war period constitute a considerable body of literature,[1] the same cannot be said of

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[*] This article develops a lecture given at the conference: Le travail d'organiser et de s'organiser. Recherches sur l'entreprise en histoire, sociologie et gestion, held at the Cité des Sciences et de l'Industrie de la Villete, in Paris from January 27-28, 2000. The lecture was published in French under the title: "Une Rationalisation par sous-projets specialisés: la fonction Entretien durant les Trente Glorieuses (1945-1975)", Cahiers du Centre de Recherches Historiques, 2000, 25: 115-127. The author would like to thank the participants at the Paris conference (especially Yves Cohen) for their comments (Yves Cohen's comments were published in the aforementioned issue of the Cahiers du Centre de Recherches Historiques, pp. 128-133).

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[1] See especially: Aimée Moutet, Les logiques de l'entreprise. La rationalisation dans l'industrie française de l'entre-deux-guerres (Paris: Editions de l'EHESS, 1997); Yves Cohen, Organiser à l'aube du taylorisme. La pratique d'Ernest Mattern chez Pegeaut, 1906-1919

the period known in French as the *Trente Glorieuses*[2] (1945-75).

We do not mean to suggest that no research concerning rationalization exists for the period 1945-75. The renewal of French sociology after the Second World War was (largely) down to the work of a new generation of industrial sociologists grouped around Georges Friedmann (1902-1977) who began to visit workplaces in order to measure the actual effects of rationalization on the very people who were subject to it.[3] However the rationalization techniques implemented by engineers during this period as well changes in these techniques over time also represent questions of historical interest which do not yet appear to have been (sufficiently) dealt with by the historians of industrial rationalization. Nevertheless, the *Trente Glorieuses* that began with a pilgrimage organized by the French state to the promised land of rationalization (i.e., the US),[4] was to witness the

(Besançon: Presses Universitaires de Franche-Comté, 2001); Eric Geerkens and Aimée Moutet, "La rationalisation en France et en Belgique dans les années 1930", Travail et Emploi, 2007, 112: 75-86.

2 Literally, 'Thirty Glorious Years' – French expression for the Post World War II boom period (1945-1975).

3 See, for example, the contributions compiled in the *Revue Française de Sociologie*, 1991, 32(3).

4 We should bear in mind that between July 1949 and November 1953, some 2,500 'missionaries' from all sorts of backgrounds – engineers, technicians, business leaders, civil servants and union representatives – traveled to the United States. They were entrusted with the task of studying the American industrial model and bringing back the 'magic recipe' this was thought to represent to France, both at the technical-organizational and industrial relations level. Concerning these productivity missions, see, for example: Richard F. Kuisel, *Seducing the French: the Dilemma of Americanization*, (Berkley: University of California Press, 1993); Dominique Barjot ed., *Catching up with America. Productivity Missions and the Diffusion of American Economic and Technological Influence after the Second World War* (Paris: Presses de l'Université de Paris-Sorbonne, 2002); Régis Boulat, *Jean Fourastié, un expert en productivité. La modernisation de la*

creation of numerous "rationally" designed turnkey factories by the Engineering departments of major French firms[5] as well as record rates of growth for French industry before ending in a crisis of efficiency and a search for new methods of producing and rationalizing[6] was thus a period of intense rationalization which is at least as deserving of historians' attention as previous periods.

France (années trente-années cinuqante) (Besançon: Presses universitaires de Franche-Comté, 2008); Marie-Laure Djelic, "L'arrivée du management en France. Un retour historique sur les liens entre managérialisme et Etat", *Revue Politiques et Management Public*, 2004, 22(2): 1-17; For an European perspective, see: Dominique Barjot and Christophe Reveillard eds, *L'américanisation de l'Europe occidentale au XXe siècle: mythe et réalité* (Paris: Presses de l'Université de Paris-Sorbonne, 2002); Jonathan Zeitlin and Gary Herrigel eds, *Americanization and its Limits. Reworking US Technology and Management in Post-War Europe and Japan* (Oxford: Oxford University Press, 2000).

5 P. Pélata, "L'industrie fordienne et l'espace français", unpublished PhD diss., EHESS, 1982; Aimée Mouter, "Etudes de temps et intensification du travail dans l'industrie française de 1945 à la décennie 1960", in *Le travail nous est compté. La construction des normes temporelles du travail*, eds Danièle Linhart and Aimée Moutet (Paris: La Découverte, 2005), pp. 28-62; Nicolas Hatzfeld, "Du règne du chronomètre au sacre du temps virtuel. Une histoire de succession aux usines Peugeot (1946-1996)", in *Le travail nous est compté. La construction des normes temporelles du travail*, eds Danièle Linhart and Aimée Moutet (Paris: La Découverte, 2005), pp. 63-73; Nicolas Hatzfeld, "L'intensification du travail en débat. Ethnographie et histoire aux chaînes de Peugeot-Sochaux", *Sociologie du Travail*, 2004, 46(3): 291-307; Konstantinos Chatzis, "Searching for Standards: French Engineers and Time and Motion Studies of Industrial Operations in the 1950s", *History and Technology*, 1999, 15(3): 233-261.

6 The literature relating to the crisis of Taylorim and the new (Post-Taylorist) patterns of industrial organization is quite extensive. See, for example, the works by: Pierre Veltz, *Le nouveau monde industriel* (Paris: Gallimard, 2000); Robert Boyer and Michel Freyssenet, *The Productive Models: The Conditions of Profitability* (New York: Palgrave Macmillan, 2002); Luc Boltanski and Eve Chiapello, *The New Spirit of Capitalism* (London: Verso, 2007, first ed. in French 1999), especially for the post-taylorist managerial discourses; Stephen Wood ed., *The Transformation of Work? Skill, Flexibility and the Labour Process* (London: Unwin Hyman Ltd, 1989); Cédric Lomba, "Beyond the Debate over 'Post'-vs. 'Neo'-Taylorism. The Contrasting Evolution of Industrial Work Practices", *International Sociology*, 2005, 20(1): 71-91.

This article is part of a broader project to study the rationalization processes that swept through major French industries during the *Trente Glorieuses*.[7] It proposes a first analysis of rationalization techniques developed in a specific domain of industrial activity, i.e., *maintenance*. The first section of the article outlines the general analytical framework we propose to use to tackle the rationalization movement implemented in France after the World War II. In the second section, this general analytical framework will be applied to the study of the rationalization of maintenance activities during the *Trente Glorieuses*. After outlining the different types of maintenance activities successively tackled by engineers' rationalizing zeal, we will focus on a limited number of rationalization techniques in order to provide an overview of the whole project to rationalize maintenance activities.

Finally, in offering a historical perspective of the rationalization of maintenance activities in France during the *Trente Glorieuse*, we wish analyze a facet of the rationalization process that has received scant attention up to now. But we also wish to draw historians' attention to the issue of *maintenance in general* which unfortunately occupies a relatively minor place in the history of technology, still dominated by an "innovation-centric picture of technology".[8]

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7 For a presentation and a first "implementation" of this project in English, see: Chatzis, "Searching for Standards".

8 This expression is borrowed from David Edgerton, "Creole Technologies and Global Histories: Rethinking how Things Travel in Space and Time", *HoST. Journal of History of Science and Technology*, 2007, 1, 2007: 75-112, on p. 79. The same historian develops a convincing argument calling on historians of technology to focus on topics like maintenance. See, for example, David Edgerton, *The Shock of the Old. Technology and Global History since 1900* (New York: Oxford University Press, 2007).

SECTION I: Rationalizing during the *Trente Glorieuses*: an analytical framework

Although it does have a number of points in common with Pre-War rationalization projects – such as separating the conception from the execution of work, disassociating innovation and routine tasks, "objectifying" and measuring work carried out by machines and laborers, breaking down the work into simple operations, and standardizing and optimizing tasks and processes, etc. – in our opinion, Post-War II rationalization is also characterized by original features that distinguish it from its Pre-War counterpart. Let us say that it represents a "second level" in the rationalization edifice built by the father of scientific management, Frederick W. Taylor (1856-1915).

The first difference is one that we will refer to only in passing. While several French "rationalizers" during the Inter-War period wished to deal both with "technical" and "social" issues (just like Taylor, himself) such as effective cooperation (ensuring mutual benefits) between workers and employers or improving the living standards of the entire population based on increased productivity,[9] Post-War engi-

9 I first developed this interpretation of Taylorism in Konstantinos Chatzis, "La Régulation des systèmes socio-techniques sur la longue durée", unuplished PhD diss., ENPC, 1993; see also Chatzis, "Searching for Standards", pp. 235-237. We may glean information in support of such an interpretation in the following publications (naturally, the authors mentioned are not responsible for the use which I make of their work): Regarding the US: Judith A. Merkle, *Management and Ideology. The Legacy of the International Scientific Management Movement* (Berkeley: University of California Press, 1980); for the situation in France: Gerard Brun, *Technocrates et technocratie en France, 1914-1945* (Paris: Albatros, 1985); Michel Margairaz, "Jean Coutrot, 1936-1937. L'Etat et l'organisation scientifique du travail", *Genèses*, 1991, 4: 95-114;

neers appear to have focused their efforts purely on technical issues.

But World War II marked another significant watershed in rationalization. Whereas Pre-War "rationalizers" were frequently "generalists", i.e., advocates of an approach and a doctrine that dealt indiscriminately with a number of different activities and functions within the firm – with priority being given to questions of production –, rationalization during the *Trente Glorieuses* was characterized both by an extension of the range of issues addressed and by the *development of specialized, autonomous rationalization subprojects*. One of the most striking features of the postwar rationalization process in France is the fragmentation of the modern firm into a series of key "functions" – i.e., organizational units established to operate in, and be responsible for, a specific activity or physical or functional area, for example the Production Department, Maintenance Department, Engineering Department, Product-Design Department, Purchasing Department, Personnel Department... Each of these "functions" produced its own management tools and its own body of rationalization techniques. Thus, engineers from the Engineering Department were concerned with rationalizing production activities, maintenance engineers rationalized the activities relating to this function and so on and so forth

Patrick Fridenson, "Un tournant taylorien de la société française (1904-1918)", *Annales ESC*, 1987, 42(5): 1031-1060. We should also note that it was not only engineers advocating rationalization who subscribed to the idea of social and economic improvement based on scientific management. Numerous French Inter-War union leaders also succumbed to the attraction of such a promise. See, for example, Georges Ribeill, "Les organisations du mouvement ouvrier en France face à la rationalisation (1926-1932), in *Le Taylorisme*, eds Maurice de Montmollin and Olivier Pastré (Paris: La Découverte, 1984), pp. 127-140.

for those concerned by the other major functions of a modern firm (Quality Control, Purchasing, Personnel Management, etc.). The creation of specialized professional journals as well as the foundation of professional associations based on the corporate function of their members are a clear sign of this specific form of rationalization during the *Trente Glorieuses,* characterized by the existence of specialized, autonomous sub-projects designed and executed by distinct "collective actors" within large French corporations.[10]

Nevertheless, a group of people that simply share the same corporate function (handling maintenance issues or rationalizing production, for example) do not constitute a "collective actor", i.e., a stable "entity" (agency), capable of designing and carrying out shared projects over the long term. The identity of a collective actor is based on language, representations and narratives involving its members. The

[10] Jean Fombonne, a former practitioner-turned-historian, recently retraced the history of the « Personnel Management » function in France. See Jean Fombonne, *Personnel et DRH: l'affirmation de la fonction Personnel dans les entreprises (France, 1830-1990)* (Paris: Vuibert, 2001). Data compiled in this publication highlights the existence of similar phenomena to those described in this article (see below). For example, the years after the Liberation of France, which, according to the author, represent the mature phase of the "function", were marked by the creation, in 1947, of the *Association Nationale des Directeurs et Chefs de Personnel* (National Association of Personnel Department Directors and Chief Executives) (ANDCP); by the organization of day-long workshops focusing on the rationalization of personnel management procedures; by the launch of a specialized professional journal: *La Direction du Personnel* (which changed its title to *Personnel* in 1968) etc. Similar developments may be noted in the "Quality Control" function. After 1945, quality-related issues were systematically dealt with in large French corporations by a distinct "collective actor". In 1956, the French automobile corporation Renault set up a Quality Control Department and a national association grouping together the specialists in this area was founded a year later (see Patrick Fridenson, "Fordism and Quality: The French Case, 1919-93", in *Fordism Transformed*, eds Haruhito Shiomi and Kazuo Wada (Oxford: Oxford University Press, 1995), pp. 160-183.

collective actor needs spaces of interaction in which professional practices and experiences can be shared and discussed and common representations and meanings can develop and be accessible to all members, thus becoming a commonly-available resource for shared projects.[11] Forums, such as study days, as well as long-distance methods of communication (and communion), such as professional journals provide both the infrastructure required to develop rationalization techniques and a collective self-image for the actors involved in rationalization.

However, in order for the specialized rationalization sub-projects sponsored by the various collective actors (engineering department engineers, maintenance engineers, etc.) to become reality within a large firm, it was not enough the actors themselves to be convinced of the merits of their own projects. They also had to be able to make their project attractive for others. First of all, they had to convince the power holders at the head of the corporation to accommodate the rationalizing practices they wished to promote within the firm. They also had to negotiate with and win over other collective actors in the firm who were also sponsoring their own specialized rationalization sub-projects with possibly

[11] The literature relating to the formation of collective actors is more extensive. See, for example: Edward P. Thompson, *The Making of the English Working Class* (London: Penguin Books, 1991; first ed. 1963); Luc Boltanski, *The Making of a Class: Cadres in French Society* (Cambridge: Cambridge University Press; Paris: Editions de la Maison des Sciences de l'Homme, 1987; first ed. in French 1982); Yves Cohen, "Industrie, despotisme et rationalisation. L'URSS et la France de l'entre-deux-guerres", *Annales HSS*, 1998, 53(4-5): 915-936; Jesper Strandgaard Pedersen and Frank Dobbin, "The Social Invention of Collective Actors. On the Rise of the Organization", *American Behavioral Scientist*, 1997, 40(4): 431-443.

conflicting requirements. Let us develop this last point a little further. Functional differentiation (specialization) within the large firm has traditionally been viewed as a kind of division of labor, the institutionalization of an intellectual project based on the inherent advantages of specialization. Our conception of functional differentiation is different. Following the system theory developed by Niklas Luhmann,[12] our approach allocates to each function, in addition to its being a part of the whole (the firm), a relation to the whole, which becomes its environment. Under this approach, a system such as a large corporation, which is internally differentiated, is more than a set of different parts segmented on the basis of maximum efficiency. Rather, it is an entity which is entirely reconstructed by many irreducible, and nearly always partial and contradictory, perspectives (one for each function). Put another way, functional differentiation necessarily introduces tensions and conflicts which originate both from the necessity of delineating "authority and responsibility decision areas" within the whole organization and, above all, from the fact that each function considers the whole firm in its own way. Indeed, as we shall see, in some respects the Post-War rationalization process in France was not only a battle between management and labor, as historians and sociologists have extensively (and often rightly) claimed, but also a kind of "civil war" between many rationalization sub-projects sponsored

[12] See Niklas Luhmann, *Social Systems* (Stanford: Stanford University Press, 1995; first ed. in German 1984).

by the different collective actors comprising large corporations.

SECTION II: Rationalizing maintenance activities during the *Trente Glorieuses*

Maintenance as an activity has always been an integral part of the world of production and is usually associated with its flaws (machine breakdowns, production stoppages, etc.). But it was really only harnessed to scientific management practices, at least in France, in the wake of the Second World War. This is not because engineers during the Inter-War period had totally ignored it and excluded it from the scope of the scientific management, but because their priorities lay elsewhere. When the rationalization process was in its infancy, it gave priority to tapping into the rich unexploited areas of the production activities. Compared to production, maintenance was relegated to the background in terms of the priorities of the engineers of the period who also considered it to be much more resistant to a policy of rationalization. Indeed, unlike leviathan and largely repetitive manufacturing operations, maintenance is characterized by its specific, discontinuous nature, and the need to respond to sudden breakdowns in the production process.

Therefore, it is hardly surprising that the technical literature of the inter-war period in France makes little mention of maintenance. The small body of publications devoted to the activity can be divided into two distinct categories.

The first category consists of texts of a directly operational nature intended for workers involved in mainte-

nance activities. They contain descriptions of different machines which workers encountered in the course of their work as well as a series of helpful hints to enable them to confront the many possible problems and to carry out the necessary *repairs* effectively.[13] Therefore, this category is made up of manuals that do not address issues of rationalization in the strict sense (e.g., planning and organizing the work related to maintenance activities, etc.).[14] It is in the publications authored by engineers interested in the rationalization of labor that we encounter the first reflections on the rational organization of the maintenance activity.[15]

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[13] See, for example, Corentine-Emile Dème, *Cours d'entretien. Avaries et réparations* (Paris: Edition et propriété de l'Ecole du Génie Civil, 1927).

[14] These manuals contain random reflections related to plans for rationalization however they never get beyond mere recommendations. Thus, in Dème's opinion, "maintenance work should include preventative measures and there is no reason to wait until a piece of equipment is in a defective state of repair before inspecting it; rather, we should inspect it when we consider that it is approaching the limit whereby it falls into disrepair" (Dème, *Cours d'entretien*, pp. 1-2). However, Dème does not go any further than this.

[15] See, in particular, MM. Michelin, "Comment nous avons taylorisé notre atelier de mécanique d'entretien ?", August 1928, special edition of *Prospérité*, a quarterly review of scientific management and economic studies edited by MM. Michelin; J. Breuil, *Méthodes modernes. L'organisation du service d'entretien dans les usines* (Vannes: Imprimerie J. Lafolye et J. de Lamarzelle, 1932); Lt-Colonel Rimailho, *Organisation à la Française* (Paris: Delmas Editeur, 1936), especially the second part, chapter IX, pp. 115-124 (the book is 430 pages long); Jean Coutrot, *Le système nerveux des entreprises* (Paris: Delmas Editeur, 1935), especially the chapter entitled "Entretien du matériel"); François Caron, "A propos de la rationalisation du travail dans les ateliers des compagnies de chemin de fer en France, 1880-1936", *Revue d'histoire des chemins de fer*, 2003, 28-29: 190-206. See also the references contained in works by Aimée Moutet: "Une rationalisation du travail dans l'industrie française des années trente", *Annales. ESC*, 1987, 42(5): 1061-1078, and Id., *Les logiques de l'entreprise.* Rationalization of maintenance activities during this period essentially concerned locomotive repair yards (the organization of major periodic equipment servicing typically involving repetitive operations such as the dismantling and reassembling of machine parts) and the central workshops of major steel factories which were actually manufacturing

Maintenance rationalization projects during the Inter-War period focused on three main themes.

The first involved transposing one of the key ideas of the scientific management movement into maintenance activities, i.e., *preparing* work prior to *executing* it. Thence, the idea of setting up a *Works Planning Unit* which should be regularly informed of the work to be done by the head of the maintenance working teams. Some members of this planning department were in charge of preparing the work slips that specified the work which the maintenance operatives had to carry out, while others had to process the "order slips" for the corresponding supplies (materials and articles required). A "tooling slip" should be attached to the "work slip" in order to cover specific tooling requirements while drawings considered useful for carrying out repairs were also to be prepared by the members of the Planning Unit and made available to those executing the work. Planning personnel also had to estimate the time deemed necessary for carrying out the repairs. We should note that even though the time specified by the members of this new department was used to calculate the bonuses paid based on the time gained by the maintenance operatives, the evaluation of such time appeared to correspond more to planning requirements than to controlling the intensity of the work effort provided by these operatives. Indeed, the times specified should serve to establish "an estimated price to be accepted by the interested party [for example, the manufacturing department], and

workshops that produced the spare parts required by the maintenance activity.

subsequently [to] correctly slot the maintenance work to be executed into the series of tasks carried out in the workshop, providing the estimating amount of time for the corresponding work stations".[16]

Those interested in the rationalization of maintenance activities during the inter-war period were not content merely to deal with the breakdown "rationally" *once it occurred*, by preparing the repair work to be carried out by operatives, for example. They also began to reflect on *preventative measures*. They stressed that "equipment to be maintained must be inspected periodically in order to make it possible to detect the symptoms of a problem before an actual breakdown occurs".[17] Special documents were to be drawn up in such a manner that "the inspection is carried out by adhering to a strict order, based on that outlined in the documents, so that attention is drawn to each aspect whose correct functioning needs to be ensured".[18] Drawing up a log of breakdowns and interventions on machines was strongly recommended. For each machine, the ultimate goal was to draw up "a logbook containing the damage incurred and the repairs carried out (dismantling, reassembling, etc.) together with estimated time and the time actually spent".[19] These logbooks should make it possible to map the past and the present states of each machine and they were supposed to be helpful in taking decisions concerning the future. Thus, if the logbook showed that repairs had to be carried out too

[16] Rimhailo, Organisation à la Française, p. 122.
[17] Ibid., p. 123.
[18] Ibid.
[19] Ibid., p. 122.

often, according to J. Breuil,[20] the author of a book dealing with maintenance methods, the machine should be modified or replaced.

However, in the opinion of the inter-war "rationalizers", rationalization of maintenance activities should not be reduced to operations on machinery only. Rationalization was considered a kind of *spiritual revolution* to shape actors' mentalities and imbue them with a sense of economic optimization which, according to the "rationalizers", was totally lacking in the workshops of this period. Thus, foremen had to realize that "a spare part was only worth keeping if it has a well-defined purpose and can actually be used". There was a need to combat the tendency of elderly foremen, and sometimes engineers, who wished to "'hold onto everything' under the pretext that 'they could always come in handy'. This may be true, however, it could actually cost money to make use of such material as buying the new nuts and bolts that you could have used would cost much less than paying somebody five francs an hour to rummage through a pile of old scrap iron".[21]

The principal themes of the maintenance rationalization project during the Inter-War period consisted of preparing repair work, preventative actions, putting together technical documentation on machine behavior and educating workshop personnel who were locked into old habits that conflicted with "best" management practices. All of these themes, which were dealt with in a rather incidental

[20] Breuil, Méthodes modernes.
[21] Ibid., p. 6.

and sporadic manner by the engineers most preoccupied by manufacturing-related issues, were to be dealt with in a more systematic and collective fashion by the engineering community specialized in maintenance issues.

The emergence and consolidation of a collective actor

> "(...) when the importance of great personalities is sidelined by the contribution and cooperation of all; when the forces contained in numbers and measures tend to prevail over much more accidental and much less durable exaltation of feelings and passions (...)"[22]

"During this period we wished to define the function of the head of maintenance operations and we concluded as follows: it was originally a general 'dogs-body', a 'go-for'; however, the 'go-for' evolved over time: he was no longer 'a drudge' as he now had mechanical, electrical and other types of devices at his disposal. We also pinpointed the antagonism that existed at this time between the manufacturing department, which had priority over everything, and the head of maintenance operations, who was at their beck and call".[23] These remarks were made by a certain Rousset at an

[22] Antoine-Augustin Cournot, *Considérations sur la marche des idées et des événements dans les temps modernes* (1872), quoted by Jacques Bouveresse, *L'homme probable* (Combas: Editions de l'Eclat, 1993), p. 19.

[23] Rousset in Bureau des Temps Élémentaires (henceforth referred to as BTE), "L'Entretien, entretenir, c'est prévoir" (information seminars held from May 5-6, 1961 on maintenance issues by BTE), *Les cahiers du BTE (n° 401-02). Quatrième série. Préparation du Travail*, p. 15 (henceforth referred to as *BTE. Journées d'information 1961*). Bureau des Temps Elémentaires (Bureau of Elementary Times) was an inter-professional association for research into work measurement. It was created in 1937

information seminar bringing together several engineers concerned with maintenance issues held some thirty years after the creation in 1933 of the *Association des chefs d'Entretien* (Association of heads of maintenance operations) by three heads of maintenance (Bertrand, Rambaud and Rousset himself).

There is a striking contrast between the maintenance function discourses put forward by "rationalizers" during the inter-war period –, reflecting a "dispassionate" and impersonal view produced by people interested in industrial rationalization in general – and the resentful assessment of Rousset, whose reflections on maintenance issues were based on personal experience and reflected his own specific position in the factory. Undoubtedly, there was a decisive shift regarding the rationalization of the maintenance function between the inter-war period of Rimailho and Breuil and the 1960s.

Indeed, after the Liberation of France at the end of the Second World War, rationalization of the maintenance function became the preserve of a clearly-defined group of actors within the firm. Based on their daily experiences, engineers specialized in maintenance now began to rationalize the various maintenance activities. They no longer merely applied the precepts of a general rationalization doctrine to a specific activity (in this case maintenance), but tailored projects based on the peculiar characteristics of this

by a group of major French firms (Alsthom, Compagnie Electomécanique, Rateau, Société Générale de Constructions Mécaniques, Société Nationale des Chemins de fer Français, etc.) and began to operate in 1941 (see Chatzis, "Searching for Standards", p. 258).

activity of which they had first-hand knowledge. Furthermore, these maintenance actors also had to carve out their own "sphere of action" within the factory and deal with the firm's other actors who were sponsoring rationalization projects of their own (see above). Thus, rationalization of maintenance activities did not take place merely at a "cognitive" level (designing and implementing efficient practices within a function); it assumed a "social", or even a "power-relationship" dimension, as it also involved regulating the relationships established between the "Maintenance" collective actor and the other actors of the firm. How did this come about?

We have already referred to the *Association des chefs d'Entretien*, set up in 1932. This provided the Maintenance function with its first representative body and provided maintenance engineers with their first forum for forging a collective identity. Once the Second World War was over, special sections set up within engineering associations and engineering consulting firms, such as CEGOS (*Commission Générale d'Organisation Scientifique*),[24] and devoted solely to maintenance-related issues also participated in the creation of the Maintenance collective actor. The gradual creation of a communication network (specialized journals

[24] *Commission Générale de l'Organisation Scientifique du Travail* (CGOST: General Commission for the Scientific Organization of Work): set up in 1926 jointly by the State and the French employer's federation; it was set up as CGOS in 1934 and became CEGOS in 1936, before becoming one of the most important French consulting firms after 1945. See Odile Henry, "Le Conseil, un espace professionnel autonome?", *Entreprises et Histoire*, 1994, 7: 37-58; Moutet, *Les logiques de l'entreprise*; Antoine Weexsteen, "Le Conseil aux entreprises et à l'Etat en France. Le rôle de Jean Milhaud (1898-1991) dans la CEGOS et l'ITAP", unpublished PhD diss., EHESS, 1999.

and special series of publications,[25] forums, seminars and courses for industry professionals[26]) provided the actors involved in the maintenance function with a constant, visible presence within the "rationalization" landscape.

The Study Days of 1949-1950

The Maintenance collective actor first came to prominence via a series of "Study Days" organized by CEGOS on May 30-June 3, 1949, January16-18, 1950, and May 15-17, 1950[27]. Maintenance engineers in various leading firms such as Etablissements Merlin et Gérin, Saint-Gobin, Société des Constructions Electriques Patay, Compagnie des Meules Norton, Etablissements Bessonneau, Socony Vacuum française (which became Mobil Oil France in 1967), Société Fran-

[25] In particular: *Les Techniques de l'Entretien* (n° 1: January 1950); *Achats et Entretien* (n° 1: January 1952). On the history of French engineering journals, see Konstantinos Chatzis and Georges Ribeill, "Des périodiques techniques *par et pour* les ingénieurs. Un panorama suggestif, 1800-1914", in *La presse et les périodiques techniques en Europe, 1750-1950*, eds Patrice Bret, Konstantinos Chatzis and Liliane Pérez (Paris: L'Harmattan, 2008), pp. 115-157.

[26] See, for example, R. Ducellier, *Organisation du travail dans les ateliers de réparation et d'entretien, leçons n° 062-062 bis*, 1956 (Courses of the Ecole de l'Organisation scientifique du travail (EOST)) (Library of the Conservatoire national des arts et métiers-Paris). The EOST was set up by the Comité National de l'Organisation Française (CNOF) in the mid-thirties (the CNOF was set up in the mid-twenties following the merger of Henri Fayol's Centre d'Etudes Administratives and the Conférence de l'Organisation Française, dominated by taylorist engineers).

[27] We should also mention the pioneering article by M. Téper (a graduate of the engineering school Ecole centrale des Arts et Manufactures (Paris) and Chief Engineer of the Paul Planus engineering consulting firm): "Organisation rationnelle d'un service d'entretien", *Chimie et Industrie*, 1947, 57(6). In this article, the author focuses on themes which were subsequently addressed in the course of the CEGOS Study Days (preventative maintenance, introduction of bonuses for maintenance operatives, etc.).

çaise de Constructions Bebcock-Wilcox, Electricité de France, Societé Française Duco, and Société Dunlop,[28] came together for several days in order to both exchange their experiences of maintenance-related activities and to develop a rational doctrine to replace the empirical approach which, in their opinion, had previously predominated. These Study Days were devoted to two issues in particular: preventative maintenance and the remuneration of staff involved in maintenance activities.

Preventative maintenance

Most participants in the Study Days felt that France had fallen way behind: "in the area of preventative maintenance, we would not exactly say that nothing had been accomplished in France, as this would be a gross oversimplification, however, much remained to be accomplished and any initiatives taken were only in their infancy",[29] declared a certain Vallée, Chief Engineer of CEGOS. A comparison with the US provided an indication of the efforts which French industrialists still needed to make in this domain. Whereas, in America, in well-organized firms, 8/10th of maintenance staff appeared to be allocated to preventative maintenance and only 2/10th to repair activities, according to the author, even in the most progressive French firms the proportions

[28] See: L'Entretien. Journées d'Etudes des 30 mai-3 juin 1949 (Paris: CEGOS, 194) (thenceforth referred to as Journées de 1949); CEGOS, L'Entretien. Journées d'Etudes des 15, 16 et 17 mai 1950 (Paris: CEGOS, 1950), pp. 25-28 (thenceforth Journées des 15-16-17 mai 1950).

[29] S. Vallée, "L'entretien préventif", in *Journées de 1949*, part 1, p. 11.

were inversed. Why did preventative maintenance in France lag so far behind?

According to the organizers of the Study Days, two factors account for this state of affairs. Firstly, maintenance departments were overworked and inundated by breakdowns in manufacturing departments which monopolized all their staff's time. This led to a self-perpetuating "viscous circle": the lack of preventative maintenance was responsible for the large number of breakdowns observed in French factories; these breakdowns in turn occupied maintenance operatives who were left with no time to devote to preventative maintenance, thence the large number of breakdowns... Add to this "viscous circle" the absence of a body of doctrine devoted to preventative maintenance and we have largely explained, according to the organizers of the Study Days, why preventative maintenance was virtually unknown in France at the end of the 1940s.

There were two obstacles to carrying out preventative maintenance in Post-War II France, i.e., two fronts along which the engineers of the period could attack. In order to break out of the viscous circle which we have just described, a major organizational overhaul of the traditional maintenance department appeared necessary: "there is only one way out and that is to *take a firm decision to set up a Preventative Maintenance Service within the Maintenance Department* [the italics are ours]. Once such a decision has been taken this service must have complete autonomy and under no circumstances should the people working in this section be transferred to day-to-day maintenance tasks (...).

The staff transferred to such a service must stay there even if the factory roof is caving in!".[30]

Whereas maintenance departments were traditionally organized on *an activity basis* (mechanics, boiler works, electricity, buildings, etc.),[31] engineers who were advocates of preventative maintenance wished to experiment with a new organizational approach: *a functional approach* that organizes the maintenance department according to its two major types of activities, i.e., *repair* and *preventative maintenance*.

This led to a debate between the participants in the Study Days as to the structure of the Maintenance Department that needed to be created. While no definitive doctrine was finalized in this regard, a consensus appeared to have been reached by the participants at the Study Days regarding the criteria for choosing between the two types of organization. Thus, for small firms requiring reduced maintenance services which did not have the resources to set up two autonomous maintenance structures (i.e., dealing with breakdowns and preventative maintenance) given the risks of such a strategy in terms of under-utilization of labor, organization by activity remained the best option. However, "for large firms where 150 to 200 people are involved in

[30] Ibid., pp. 14-15.

[31] A survey of 21 firms carried out by CEGOS in 1949 showed that 14 of them had Maintenance Departments organized by activity, 2 used a functional organization and 5 had a mixed organization (CEGOS, *L'Entretien. Journées d'Etudes des 16-17-18 janvier 1950* (Paris: CEGOS, 1950) (thenceforth, *Journées des 16-18 janvier 1950*). See also the description of a "typical" Maintenance Department organized by activity provided in Breuil, *Méthodes modernes*.

maintenance activities, a functional organization is preferable".[32]

However, although the creation of a functional organization made it possible to break out of the spiral of endless breakdowns by according preventative maintenance an autonomous role within the Maintenance Department, it only constituted a first step in the development of preventative maintenance. It would have remained an empty shell in the absence of a body of doctrine devoted to new tasks of preventative maintenance. At the CEGOS Study Days, a significant amount of time was devoted to developing such a doctrine. A report dealing with maintenance-related issues drawn up following productivity assignments to the USA led by English industrialists and engineers provided participants with the first elements just such a sought-after doctrine.[33]

In this report, we encounter the *principle of regularity*: once the different operations involved in preventative maintenance have been identified (e.g., lubrication, verification, settings, standard replacement), they must be performed by workers in accordance with a set plan whose implementation will be closely monitored by first-level management (the maintenance foremen) on the basis of work reports. The operations must be performed regularly and be

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32 Aimé Périer, "Conclusion et programme de travail" in *Journées des 16-18 janvier 1950*, p. 33.

33 The United States, which welcomed a number of productivity missions during the 1950s, also participated in the creation of a "Preventative maintenance" doctrine via the *Commissariat du Plan* (Commission for the National Plan). Thus, the mid-1950s witnessed the setting up of several maintenance groups within the Regional Productivity Committees created under the impetus of the *Commissariat du Plan* (see the accounts of Marcel Aupetit, published in *BTE. Journées d'information 1961*, pp. 87-94).

based on knowledge of the equipment to be serviced. In the absence of manufacturers' documentation, maintenance engineers must carry out "an in-depth study at the time of installation that takes account of all the mechanical parts subject to wear and tear and the most fragile parts that may break under abnormal operating conditions". Lastly, they must note the "different setting mechanisms and the frequency with which these are used".[34] Naturally, the process of getting to know the equipment does not end once the equipment has been installed. The life of such equipment must be closely monitored by providing a true machine "semiology": monitoring and statistical processing of a certain number of indicators (consumption of lubricants, electricity, steam, etc.) established for each machine, informing those in charge of preventative maintenance of any problems or abnormal machine behavior (premature wear and tear, etc.) and enabling them to develop prevention programs.

The remuneration of staff involved in maintenance activities

"In Maintenance Departments, it is always extremely difficult to measure staff performance; it appears that there is no real basis of measurement. In the absence of such information, it is quite difficult to develop a formula for awarding performance-related bonuses".[35] Why did the issue

34 *Journées de 1949* (part 2), p. 16.
35 S. Vallée, in *Journées de 1949* (fascicule 2), p. 9.

of performance-related bonuses appear so important to French maintenance engineers in the early 1950s? The answer provided by the engineers who actually participated in the Study Days constitutes a genuine example of professional sociological analysis.[36]

"In manufacturing workshops, workers receive either an individual or group performance-related bonus while maintenance staff are simply paid by the hour. What effect does this have? We sometimes note that the skilled worker in the Maintenance Department does not earn any more than unskilled manufacturing workers who, thanks to their 33% bonus, make as much over a two week period as the skilled maintenance operative (...). Each time we encounter a situation like this, we cannot fail to note a certain uneasiness, or at the very least a lack of job satisfaction, and it is common to hear remarks (I have heard them in all types of different firms) such as: 'What's the point in learning a trade if you're only paid the same as an unskilled laborer'".[37] For the engineer *cum* sociologist quoted here, the "democratic spirit" dissected by Tocqueville in his classic analysis, *Democracy in America*, was spread in the factory. The constant comparison made by skilled maintenance operatives between their own position and that of their unskilled manufacturing colleagues, are themes which continually preoccupied main-

[36] Regarding the figure of the engineer-sociologist, see Michel Callon, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis", in *The Social Construction of Technological Systems*, eds W.E. Bijker, Th.P. Hughes and T.J. Pinch (Cambridge (Mass.): The MIT Press, 1987), pp. 83-103.

[37] S. Vallée, in *Journées de 1949* (part 2), p. 9.

tenance engineers.[38] They considered that cross-comparisons, which are a potential source of conflict and demotivation, must be neutralized at all costs. But how?

Manufacturing workers received bonuses. Maintenance workers "envied" them. In order for the envy and resulting demotivation to cease, maintenance personnel would also have to receive bonuses. But how could such bonuses be calculated given that the activities of the maintenance operatives, unlike those of their manufacturing worker colleagues, appeared to be "unmeasurable" in terms of a scientific analysis of tasks?[39] Two possible ways of proceeding were examined by the participants at the CEGOS Study Days.

The first was a line of action *that remained internal* to the Maintenance function. If it proved impossible to "measure" the maintenance activity, then why not try to control its results? Thus, certain engineers proposed to pay maintenance operatives a bonus based on compliance with budgeted maintenance costs. This was a possible solution, however other engineers countered that maintenance foremen would be very likely to cheat, given that the temptation to set forecasts that were sure to be met would probably prove too strong. What about a bonus based on machine availability? Possibly, however such availability was the result of a number of factors which were not controlled by the Maintenance Department, such as the way in which the

[38] As regards the issue of comparisons between people and the feelings (such resentment) this may generate**,** see also Jean-Pierre Dupuy, *Le sacrifice et l'envie* (Paris: Calmann-Lévy, 1992).

[39] See Vallée, in *Journées de 1949* (part 2), pp. 13-14.

machines were handled by the manufacturing workers, the age of the machines in the workplace, etc.

As the first "internal" (to Maintenance Department) line of action proved to be full of pitfalls, the participants proposed another solution: why not reward the *de facto* solidarity shown in terms of the availability of the machines for the various actors in the firm by paying *an identical group bonus to the manufacturing workers and the maintenance staff*: "the manufacturing workers are paid an unskilled labor rate while the maintenance operatives receive a skilled labor rate. If they all receive the same type of performance-related group bonus (say 25%, 35% or 40% of their base wages) there would be an incentive for everyone. Thus, the maintenance operatives have the impression that justice has been done and indeed, they are much more productive and set about their work with much more urgency. For their part, the manufacturing workers constantly harass the maintenance operatives to ensure that their machines do not break down as this would lead to production stoppages, a dip in individual productivity and a sharp fall in their bonuses".[40]

Let us analyze this view a little further. It illustrates a general "management technology" which we could term *the*

[40] Ibid., p. 10. An (anonymous) factory manager having experienced this idea of a common bonus provides this informative comment: "In my factory, the manufacturing workers provide me with precious aid in controlling the performance of maintenance operatives (...). I frequently have to listen to the complaints of Manufacturing Department foremen who consider that maintenance operatives take far too long to carry out relatively simple tasks. Therefore, the new bonus for both categories has the fortuitous effect of making it possible to increase the output of workers whose output is difficult to monitor." (Ibid., p. 11). We encounter the same line of reasoning in *Journées de 15-16-17 mai 1950*, pp. 24-28.

ideal of automaticity which allows the engineer to channel the workers' (supposed) interests and feelings in the direction wished for. The engineer builds a self-regulated system capable of accomplishing the plans designed by the engineer without any external intervention. The reason we attach so much importance to the ideal of automaticity is that we will see it in action on several different occasions when the engineer comes to implement his rationalization project.[41]

As we have seen, issues concerning preventative maintenance and systems of remuneration were ever-present during the three Study Days organized by the CEGOS. These two issues continued to mobilize a considerable portion of maintenance engineers' energy during the 1950s. Another issue soon emerged that was to broaden the themes covered by their rationalization project: the planning of repair work.

[41] Concerning the origin of the ideal of automaticity, see Otto Mayr, *Authority, Liberty and Automatic Machinery in Early Modern Europe* (Baltimore: The Johns Hopkins University Press, 1986). H.L. Gantt, a disciple of F.W Taylor, offers to use this idea to regulate the relationship between workers and foremen in *Travail, Salaires et Bénéfices* (Paris: Payot, 1921, first ed. in English 1910), ch. 8. For a series of examples of the implementation of the ideal of automaticity by engineers, see Konstantinos Chatzis, *La pluie, le métro et l'ingénieur. Contribution à l'histoire de l'assainissement et des transports urbains (XIXe-XXe siècles*) (Paris: L'Harmattan, 2000); Chatzis, "Searching for Standards".

1950-1960: The experimental years

From systematic preventative maintenance to systematic (scheduled) inspections

Once the CEGOS Study Days devoted to maintenance issues were over, the development of preventative maintenance, "this serum that provides equipment with a long life" in the words of Aimé Périer – an engineer from the Ecole Centrale des Arts et Manufactures[42] and, as we shall see, one of the leading "rationalizers" of maintenance activities –, undoubtedly figured as an essential task to be carried out by the heads of maintenance departments. In the 1950s, the reflections developed during the Study Days of 1949-50 were further developed and some of them were transformed into a system of operational techniques.

The euphoria created by the notion of preventative maintenance, which was supposed to turn most production breakdowns into a thing of the past, quickly subsided once a simple fact sunk in: extensive preventative maintenance applied on a large scale (for all machines in the Production Department) is very expensive. Thence, the modification of the original doctrine and the transition, for most equipment, from *systematic preventative maintenance* to *systematic (scheduled) inspections*. Instead of applying systematic maintenance to the equipment (changing worn out parts,

[42] Concerning the history of French Engineering schools, see Konstantinos Chatzis, "Theory and Practice in the Education of French Engineers from the Middle of the 18th Century to the Present", *Archives internationales d'histoire des sciences* (forthcoming).

etc.) according to a fixed timetable, maintenance "rationalizers" now proposed to inspect the machines at regular intervals and take action based on an assessment of the machine status by *the inspector*, an original professional figure created to carry out the new task of inspection. Obviously, the new doctrine was a lot less costly in terms of money (no systematic replacement of spare parts) and time (according to the engineers, an inspection lasts a quarter, or even one-tenth of the time required for systematic maintenance).

Once the notion of systematic (scheduled) inspections had been introduced, it had to be made operational. Thus, standard inspection sheets were prepared that indicated for each machine the points to be monitored, the inspections to be carried out and the operations to be performed on-site. As regards the design of these sheets, the idea was to "include too much rather than too little detail so that the work could be done by other people in the event of the regular operative's absence".[43] In order to be sure that the inspector (whose "subjectivity" is supposed to be neutralized by the detailed nature of the instructions) complies with the recommendations contained in the inspection sheets, the maintenance "rationalizers" invented clever little control tricks: "Inspectors must also complete an on-site report of their inspection in which they are responsible for each key point on the inspection sheet. This report must be completed in the columns on the right hand side of the machine

[43] Aimé Périer, *Entretien et constructions en usine. L'organisation du service* (Paris: Editions de l'Entreprise moderne, 1959), pp. 92-93.

inspection sheet and the inspector simply puts a cross in one of the columns marked N, F or R: N stands for nothing to report; F for minor repairs identified and carried out by the inspector; R stands for repairs to be carried out for which a works request form has to be submitted. In this latter case, the inspector simultaneously fills out the works request form as he also has a book of work request vouchers for this purpose. The idea of combining the inspection sheet and the book of vouchers *forces the inspector to actually bring the inspection sheet and thus to monitor the list of key points during the inspection instead of working from memory*" [the italics are ours].[44]

Even though inspection largely replaced systematic preventative maintenance, the latter did not disappear altogether. Systematic preventative maintenance was now reserved for key equipment parts and security facilities where a breakdown could pose a serious threat to personnel. The machines in the workshop were firstly listed and then categorized in terms of their importance in ensuring an uninterrupted production process.

The last remaining task for maintenance engineers was to define the frequency of inspections and systematic replacement of spare parts for facilities subject to systematic preventative maintenance. 1950s engineers proceeded by successive approximations. Thence, they started off at a "rate that was obviously too low" and extended the time between

44 R. Jabot, *Entretien et Travaux neufs* (Puteaux: Editions Hommes et Techniques, 1969), pp. 85-86.

two inspections until the incidence of breakdowns became unacceptable.[45]

What organization for the Maintenance Department?

Another issue debated at length during the 1950s was the organization of the Maintenance Department. As we have already seen, the emergence of preventative maintenance had a major impact on the traditional approach to organizing the department. Engineers captivated by notions of preventative maintenance wished to replace organization by activity (mechanical, electrical, etc.), *known as organization by trade*, with a functional approach that divided maintenance operatives into two groups: the first group handled breakdowns (repair function) while the second looked after preventative maintenance.

The opposition between the advocates of these two organizational approaches blurred over time. Maintenance engineers realized that a functional approach and an approach by trade (organization by activity) were not mutually exclusive and may coexist within the Maintenance Department. In fact, several combinations are possible. Thus, a given department could be organized by trade with sub-divisions organized on a functional basis. Moreover, engineers began to appreciate the positive aspects of the traditional organization of maintenance activities. Indeed, organization by activity came to be considered more effective than functional organization when a certain number of

[45] Périer, Entretien et constructions, pp. 49-54.

circumstances are present.[46] Thus, in a firm where few breakdowns occur, organization by activity was recommended. The reason provided by engineers was the following. In a situation where there is not a large volume of breakdowns (stable environment), problems of coordination between the different specialized maintenance operatives are of secondary importance. It is rather the variable "chain of command" that is most important in deciding on the choice of organization. Organization by activity appeared to produce the best results from a "chain-of-command" perspective as the maintenance teams are managed by specialists in a particular area,[47] who, thanks to their expertise have a sort of moral authority over their subordinates (as we can see, division of labor also has a political dimension[48]).For maintenance engineers, functional organization would be chosen as a basis for organizing the Maintenance Department only when the volume of preventative maintenance work is significant.[49]

Along with debates and arguments over alternative Maintenance Department organization patterns (organization by activity versus functional organization), this period

[46] Ibid., p. 142 *sq*.

[47] In the case of organization by trade, experienced mechanics are in charge of teams of mechanics, experienced electricians are placed in charge of electricians, etc., whereas in the functional model, the head of a "repair" team or a "preventative maintenance" team is in charge of both mechanics and electricians.

[48] We refer to the seminal work by Stephen A. Marglin, "What do Bosses do? The Origins and Functions of Hierarchy in Capitalist Production", *The Review of Radical Political Economics*, Part I, 1974, 6(2): 60-112; Part II, 1975, 7(1): 20-37.

[49] For a more detailed discussion of this point see, Périer, *Entretien et constructions,* pp. 141-144, and Périer, in *Journées de 1949*, part 1, p. 29.

also witnessed the emergence of other heated issues, this time concerning centralization vs. decentralization. As in the case of the aforementioned debate, single best-way solutions were avoided. Instead of proposing a unique formula, maintenance engineers identified different work contexts and established several selection criteria. As such, given that centralization has several advantages (more effective coordination of teams, ability to control and monitor staff, reduction in the number of managers and employees), it should be chosen as a solution whenever possible. However, decentralization is recommended when the factory is spread over a wide area and the average time taken for maintenance operatives to get from one place to another exceeds ten minutes.[50]

A new topic: the planning of breakdown repair work

Maintenance "rationalizers" penchant for calculation, their obsession with order and their desire to forecast and plan for everything were not restricted to the domain of preventative maintenance. Breakdown repair work, a topic that had previously been seen as an irregular, hazard-related activity, and thus clearly excluded from the scope of scientific management, would gradually come to interest the engineers preoccupied with the rationalization of the maintenance function.

In order to "rationalize" repair work, maintenance engineers tried to imitate the example set by those who had

[50] Ibid., pp. 116-117.

rationalized manufacturing activities. The idea was to slot in a third activity between the occurrence of the breakdown and the repair work, i.e., *planning*, and to provide the operative with "a clearly-defined job, as well as the most suitable techniques and means for carrying out the job, the list of materials required and available and the time needed [for the operations]. This in turn provided an idea of the deadline and the wages of the staff involved".[51] However, unlike preventative maintenance whose benefits were immediately recognized by engineers specialized in the maintenance function, the notion of preparing breakdown repair work was much more difficult to put into practice. Before trying to develop a doctrine, it was first necessary to convince the "skeptics" who challenged the very purpose of such a project. How is it possible to prepare for the unforeseeable? And, even if we actually manage to do this, would the operation be worth the cost, given the once-off, non-repetitive nature of breakdowns and the related repair work?

In the face of such objections, advocates of planning replied that the first thing to do was to disprove the standard idea of repetition that people spontaneously associate with manufacturing: "when we think of repetition, we immediately think in terms of major production volumes and even of assembly lines. But repetition takes place here over a very short time (...). For us maintenance engineers, (...) [the] similar-type work does not recur very frequently. However, over ten, fifteen, twenty or even fifty years, i.e., the duration of a building or a piece of equipment, the same work

[51] Périer, Entretien et constructions, p. 81

frequently recurs several times, particularly if we have taken the trouble to break it down into basic units which recur more often, but in different maintenance work contexts".[52] For those who advocated preparing breakdown repair work, the solution was to harness the *analytical ideal*[53] to maintenance issues (that is, break down the problem to be dealt into its basic parts) and choose an appropriate time horizon that would highlight the repetitive (common) elements of different repair activities that can be subjected to planning work (e.g., dismantling and reassembling parts which have broken down for a variety of reasons).

Once it had been decreed that planning for breakdown repair activity[54] was indeed possible, such planning had to be endowed with a rational doctrine. Who would carry out such planning? What relationship would this person have with the on-site maintenance foremen and their repair works team? What rules should guide their action?

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52 Ibid., p. 82. We should point out that Périer also published two other works which were intended not for the engineer in charge of the Maintenance Department but for maintenance foremen: Aimé Périer, *L'Agent de maîtrise et l'entretien du matériel* (Paris: Les Editions de l'Entreprise moderne, 1955); Id., *Guide du chef d'entretien* (Paris: Editions Hommes et Techniques, 1953; 2nd ed.).

53 Concerning the analytical ideal and its various applications in the field of engineering, see Chatzis, *La pluie, le métro et l'ingénieur* ; Chatzis, "Search for Standards".

54 Planning comprises the following: the list of operations to be carried out and their scheduled execution over time, the duration of each operation, technical guidelines, preparation of materials (materials issue sheets), daily progress and workload, cost evaluation of the work requested on the work slip based on the labour and materials required to carry out such work, flow chart of the global workload for the different works section.

The maintenance planner and the on-site repair team

Guided by the idea that a special structure had to be set up for each specific function,[55] some maintenance engineers decided to introduce a new figure into the work environment: the maintenance planner in charge of carrying out the new planning tasks. However, slotting this new actor into the existing structures also introduced a risk of conflicting lines of command (maintenance planner and on-site maintenance foreman).[56] In response to such a risk, rules setting out the precise functions of each actor, as well as techniques for controlling whether the division of tasks between planner and on-site foremen was complied with, were gradually introduced by maintenance engineers. Thus, the maintenance foreman was forbidden from starting a new job without first consulting with the maintenance planner, while the latter was to restrict his role to planning and was forbidden from interfering in the subsequent execution of the work. Engineers gradually introduced clever ways of keeping the maintenance planner and the works foreman in check and ensuring that each complied with their respective roles. In order to prevent maintenance planners from being

55 Maintenance engineers explicitly echoed Henri Fayol (1841-1925), the French Scientific Management theoretician who advocated this approach. See Konstantinos Chatzis, "L'analytique des tâches et l'entreprise comme corps", *Cahiers d'histoire et de philosophie des sciences*, 2006, special issue: 261-265.

56 Thus, Périer recounts the experience of introducing a process planner into the firm (Etablissements Merlin et Gérin) where he was working at the end of the 1940s: "the first [difficulty] was the overlapping chain of command which became a serious obstacle. When urgent breakdown work had to be carried out, the process planner, who had previously been an on-site maintenance foreman, tended to bypass the head of the maintenance works team, i.e., the person actually responsible for carrying out the work" (*Journées d'Entretien de 1949* (part1), p. 25).

bypassed, maintenance "rationalizers" provided planners with counterfoil books. They were the only ones in possession of such books and they used them to assign a numbered work slip to each job to be carried out. Workers' wages came to be based on such work slips. As payment was contingent on the existence of a work slip issued by the maintenance planner, workers were well-advised to refuse any orders issued by a works foreman that were not substantiated by a work slip. Thus, works foremen who were tempted to bypass the planner would be reined in by their own workers. This is another example of the ideal of automaticity transformed by maintenance "rationalizers" into a "disciplinary technology"[57] intended to make it possible to self-regulate the collective work environment without the constant intervention of the engineer.

As the centerpiece of the new rationalized maintenance function, maintenance planners risked being the cause of numerous problems if their estimates (especially those in respect of the time allocated to carry out specific maintenance tasks) turned out to be inaccurate. Thus, engineers proposed methods designed to assist the planners in their judgments as well to control them. "The recommendations in this respect are both to exercise care when choosing the technician who will subsequently estimate the time required, and to train this technician in Descartes' 'advice' of breaking down a problem into its simpler constitutive elements so that all estimated times concern short (elementary) mainte-

57 To use Foucault's terminology. See Hubert L. Dreyfus and Paul Rabinow, *Michel Foucault: Beyond Structuralism and Hermeneutics* (Chicago: The University of Chicago Press, 1982).

nance operations. Thus, there will be less errors in absolute terms and in keeping with the statistical law of "large numbers", the total number of errors in relative terms will be very low. It should be pointed out that this is the most widely used method in the area of maintenance".[58] As we can see, statistics are used by maintenance engineers of the period not only as quantitative operators but also as a basis of reasoning and justification: application of the analytical ideal, combined with the law of large numbers, leads, via a sort of automatic elimination of errors affecting each elementary operation, to global estimates deemed sufficiently accurate with regard to practical needs.

We should note that the emergence of maintenance planners was to profoundly alter the question of the remuneration of maintenance staff. Their estimates of the time to be allocated to various maintenance tasks rendered common bonuses, shared by both maintenance and manufacturing operatives, obsolete; as we have seen, these were offered by maintenance engineers at a time when it was difficult to control the activities of workers involved in maintenance activities and the time required to carry out the different operations (see previous section). In fact, from the 1960s on, remuneration ceased to be a preoccupation for engineers focused on rationalizing the maintenance function.

[58] Périer, Entretien et constructions, p. 86.

Dealing with the other actors of the firm

Although the rationalization project developed by maintenance engineers was mainly applied to the internal activities of their corporate function, they also put a lot of energy into reshaping the relationships between the maintenance function and the other actors of the firm, such as the Production or the Purchasing Departments, or the leading corporate decision-makers.

1) Getting to grips with the Production Department

Thanks to inspection sheets, machine files and other documents for preventive maintenance and planning repair work, Maintenance Departments began to develop a "literacy" or "writing culture" ("scriptural economy", in the words of de Certeau). Maintenance engineers were not merely content to develop this new culture within their departments, they also wished to expand it in their dealings with other departments throughout the firm, in particular, with the Production Department. Thence, all requests emanating from this department now had to be made in writing and reach the Maintenance Department in accordance with carefully defined procedures and communication channels.[59] Setting all communications down in writing had several advantages. Apart from the fact that it avoided sub-

[59] Périer, *Entretien et constructions,* pp. 55-63. On the (formal internal) written communication within modern manufacturing firms, see the classic JoAnne Yates, *Control through Communication: The Rise of System in American Management* (Baltimore: The John Hopkins University Press, 1989).

sequent complaints by manufacturing agents (requests not complied with, disputes concerning the nature of the work requested, etc.), a document-based approach reinforced the "recall capacity" of the various actors within the firm: "[the work slip] is a document that follows each job regardless of whether it is actually carried out or not. In any case, this job will not be forgotten".[60] Moreover, written documents did not serve merely to passively record oral conversations, they also function as instruments capable of making information more precise and extracting more information – things which an oral exchange can never hope to do: "[the work slip] is also a way of forcing the person making the request to provide the necessary information as accurately as possible. This is frequently a major problem when carrying out our work: i.e., unclear requests".[61] Lastly, we should note that forms are a way of saving time while they also guarantee a certain degree of correctness (that requests will be properly expressed and correctly received): "Forms ensure that all information is provided in a well-ordered manner; firstly, the person making the request does not forget anything (...), while the Maintenance Department always looks for a given item of information in the same place on the document and thus avoids loosing time and sometimes even omitting certain details, which can happen when the request is written on a simple sheet of paper (...)".[62]

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[60] Périer, Entretien et constructions, p. 55.

[61] Ibid.

[62] Ibid., p. 56. Maintenance engineers "agree" here with Jack Goody, *The Domestication of the Savage Mind* (Cambridge: Cambridge University Press, 1977) and Michel de Certeau, *The Practices of Everyday Life*

Thus, maintenance engineers no longer wished to respond to non-formal, oral requests formulated by the Manufacturing Department, and they also wished to control the exact timing of the execution of maintenance. Thence, a struggle began between the Maintenance Department and the Production department regarding the priorities to be assigned in respect of maintenance work requested. "If everyone in the firm acted in a reasonable manner, it should definitely be the Manufacturing Department (...) that sets these [the order of priorities]". However, according to maintenance engineers, the lack of trust and the fear of "being had" led manufacturing managers to act in an "uncooperative and selfish" manner, to use the vocabulary of game theory: "the typical reaction is (...) to think that if we don't request the work immediately it will be forgotten about and never get carried out". Thence, it was up to those in charge of maintenance to restore the missing trust: "this is a major problem that must be overcome (...): the Maintenance Department must meet the deadlines it has promised at all costs in order to gain its customers' trust".[63]

2) Getting to grips with the Purchasing Department

The desire of the maintenance engineers to redefine their relationship with the other actors in the firm did not merely concern the Production Department. Dealings with the Purchasing Department were also the subject of

(Berkeley and Los Angeles: University of California Press, 1984; first ed. in French 1980), on the powers of "literacy" and of "writing".

[63] Périer, Entretien et constructions, p. 96.

discussions among maintenance engineers. Although most engineers did not subscribe to radical solutions that advocated creating an internal purchasing service within the Maintenance Department, everyone agreed that the relationship between these two departments, which had always been characterized by conflict and tension, needed to be reconsidered. Firstly, the two departments, whose actions were guided by different (and often conflicting[64]) approaches, needed to be brought closer together. Therefore, in the view of maintenance engineers, the Purchasing Department should stop assessing equipment solely in terms of price, while the Maintenance Department for its part, should pay more attention than in the past to the cost of the equipment which it uses.[65] As such, maintenance engineers proposed a compromise to their colleagues in the Purchasing Department: "we in maintenance must clearly specify the deadlines for receiving the equipment and material we need as well as their technical features. The Purchasing Department must then obtain this equipment and material at the most competitive price".[66]

64 "(...) it is not unheard of in certain firms for this department [Purchasing] to claim the right to cancel certain orders on the grounds that it does not consider them to be justified" (Ibid., p. 182).

65 "Let us just say a few words on this matter which, unfortunately, is a sore point in many firms. To be perfectly frank, we must admit that for us, all too frequently, price is not a real consideration and only technical aspects are important. On the other hand, for the Purchasing Department, price is everything and technical considerations are of no importance" (Ibid., p. 187).

66 Ibid.

3) Getting to grips with Top Management

As we have just seen, management engineers wanted to redefine relationships with the firm's other actors. But wanting something is one thing, actually being able to do so it another matter. Simply being convinced of the well-founded nature and purpose of a project to which one subscribes is obviously not sufficient to have such a project implemented. In order to develop their rationalization project, maintenance engineers had to "enroll" the decision-makers at the top of the corporation and get them "interested" in their cause.[67] This accounts for the development by maintenance engineers of several "persuasion programs" targeting top management. Such programs usually relied on the power of concrete (quantified) results to convince. In order to plead the cause of preventative maintenance, engineers presented sets of figures (cumulative maintenance costs, cumulative costs related to non-operational equipment, rate of breakdowns, etc.) in respect of two groups of identical machines, only one of which had been subject to preventative maintenance, thus illustrating the benefits of such an approach.[68]

But before presenting convincing results, one must be able to produce these. Sometimes, dominant beliefs preassign a project a judgment so unfavorable that they do not even allow it the opportunity to defend its potential benefits "in action". In order to be able to produce diagrams illus-

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[67] On the "interest" and "enrollment" issues, see Bruno Latour, *Science in Action. How to Follow Scientists and Engineers through Society* (Milton Keynes: Open University Press, 1987).

[68] Jabot, Entretien et Travaux neufs, pp. 87-88.

trating the economic benefits of preventative maintenance and, more generally, the planning of maintenance work, the Maintenance Department had to recruit some new figures such as planners and inspectors into its ranks. Obviously, an increase in the number of maintenance staff equals an increase in the so-called indirect labor costs (ILC) (costs related to people who do not perform production tasks directly). Given French top managers' obsession with the "Indirect Labor Cost / Direct Labor Cost (ILC/DLC)", ratio, which it wished to keep as low as possible,[69] there was a good chance that it would be opposed *in principle* to any project that leads to an increase in indirect labor costs. Thence, the efforts by maintenance engineers to replace the ILC/DLC ratio by a ratio that would cast their project in a more favorable light: "top management had to be persuaded to replace the ILC/DLC ratio by the:

(ILC+DLC)/Volume of production

ratio under which maintenance engineers can demonstrate the benefit of planning maintenance work (if the denominator increase faster than the numerator).[70]

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[69] For example, in the early 1900s, the famous French industrialist Louis Renault was not favorable to Taylorism because of the increase in indirect labor costs which it generates. See, for example, P. Fridenson, "Un tournant taylorien".

[70] *Le Service Entretien. Méthodes actuelles de gestion* (Paris: Entreprise Moderne d'édition, 1968), p. 78. This book consists of a collection of major articles first published in the journal *Revue Technique de l'Entretien et des Travaux Neufs*, and representing the state-of-the-art maintenance procedures. The collection is edited by Aimé Périer who also contributed introductions inserted at the beginning of each chapter. In tackling the role of management tools, maintenance engineers apply here a sociological approach which was subsequently developed by

Building a collective "self image"

At the end of the 1950s, maintenance engineers displayed all the features of a collective actor. Their rationalization project was based on collective self-awareness, clearly illustrated via a series of narratives. We have already referred to the bitterness apparent in the accounts of maintenance engineers at the beginning of the 1960s when recollecting their "function's" past. This recollection of a "bleak" common past, a first expression of a collective "we", was to be enriched in the 1950s by other narratives, enabling maintenance engineers to create "a feeling of togetherness".

1) Highlighting the specific nature of maintenance activities (differences with manufacturing operations)

"Firstly, maintenance work is of a unitary nature; no two jobs are ever the same; there is a mixture of difficulties that constitute a cocktail (...) which is always different and always contains something new. Finally, this unitary, urgent work prevents an in-depth, detailed review being carried out from an economic perspective".[71] Infinitely more varied than manufacturing, maintenance work is, according to maintenance engineers, also much more satisfying for the person carrying it out. Here, it is not the machine that dominates

researchers in the field of organizational studies. See, for instance, Michel Berry, *L'impact des outils de gestion sur l'évolution des systèmes techniques* (Paris: Centre de Recherche en Gestion – Ecole Polytechnique, 1983).

[71] Périer, *Journées de 1949* (part 2), p. 3.

man, but the opposite: "In maintenance operations, it is typical to encounter the 'man-machine system' that we find in production and in which the machine plays the dominant role. Here, this is played by man; you have to train him, not only tell him, but explain to him the goal being sought after (...)".[72]

2) Manufacturing and maintenance: father and doctor

The metaphor of the medical profession is omnipresent in the speeches of maintenance engineers during this period, who use this metaphor to represent their position and function in the factory and their relations with the Production Department. "You have to picture the manufacturer as the "father" of the equipment. Just like any good father whose child is sick, he calls on competent people, i.e., the medical corps consisting of doctors, nurses and even specialist equipment. Thus, the medical corps is the Maintenance Department. It includes 'doctors', i.e., technicians who carry out the diagnosis and the serious operations, as well as the 'nurses' in charge of administering day-to-day care: lubricating operatives, preventative maintenance workers and operatives in charge of replacing a unit whose condition has deteriorated. Furthermore, as in the case of clinics, hospitals and the health services, there is even equipment that corresponds to that found in these establishments. The operating tables, surgical and medical instruments corres-

[72] Marcel Gilly, in BTE. Journées d'information 1961, p. 14.

pond to the dismantling, repair and test equipment present in our department".[73]

3) Looking for illustrious predecessors

Little by little, maintenance engineers came to produce a collection of illustrious men whose reflections were to be enlisted to support their own rationalization project. Thus, a certain Pierre Salmon kicked off the Study Days organized by the Bureau des Temps Elémentaires in 1961 by recalling Dautry's aphorism: "a firm may be judged (and these are not my words, but those of one of our illustrious predecessors, Mr. Dautry) in relation to its maintenance function".[74] And another maintenance engineer named Marcel Gilly had no hesitation in evoking Rousseau to explain why the maintenance function suffered so badly in the past (in France): "The French take care of nothing and do not respect any monument; they are all action, full of passion to embark upon projects; but all too frequently, they finish and take care of nothing".[75]

4) A brighter future

The identity of collective actors is forged over time. They draw experience both from the past and the present; in

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73 Périer, Entretien et constructions, p. 28.

74 *BTE. Journées d'information 1961*, p. 6. On Raoul Dautry, an engineer who graduated from the Ecole polytechnique, see Rémi Baudouï, *Raoul Dautry (1880-1951). Le Technocrate de la République* (Paris: Balland, 1992).

75 BTE. Journées d'information 1961, p. 10.

relation to the future, they form expectations while they also have hopes and fears. At the beginning of the 1960s, an analysis of the technical and economic development of industrial systems carried out by engineers involved in the maintenance activities reinforced their impression of serving a function with a bright future. Indeed, the impending increase in automation and competition discernable at the beginning of the 1960s was interpreted by these engineers as having a beneficial impact on the maintenance function. Here is a brief account of the history of industry as interpreted by maintenance engineers in the early 1960s. *Before* "was a time when a boiler, a steam engine, a tool/engine or a trade lasted two or three generations. Technical progress and the related developments with regard to competition were slow, it was easy to recoup costs and investments were infrequent. This department [maintenance] was so ill-considered that frequently, for 'admirably charitable reasons', it was allocated elderly or physically diminished workers who were no longer able to function properly in the production department (...)". *How times have changed!* The future looks very different. "In modern firms, machines are more and more complicated and costly. It is essential to recoup costs as quickly as possible, which means that they must have a very high usage rate".[76] Therefore, new automatic machines must be serviced by increasingly skilled workers. However, automation did not merely account for the increased level of skill required from maintenance operatives. It provided a new basis for allocating work between Production and Mainte-

[76] Ibid., p. 11.

nance Departments: increased automation in the future would result in less and less manufacturing staff. Thus, the maintenance function is set to monopolize jobs requiring high skills and increased responsibility and most positions within the industrial structures of tomorrow.[77]

Rationalizing maintenance operations in the 1960s: continuity and extensions

Continuity

Reflections concerning work planning, both in terms of preventative maintenance and breakdown repair work continued unabated. Whereas, in the 1950s, such analyses focused on the mechanical component of maintenance work, engineers now began to tackle repair breakdown work relating to the electrical and automated part of machinery. Unlike mechanical breakdowns, which were immediately visible (cracks, etc.), electrical faults and those relating to automation were harder to tackle. There was a considerable gulf between the symptoms observed (equipment malfunction) and locating the cause of the breakdown and this had to be bridged by the skill of the breakdown repair operative. As an engineer noted when referring to automation, "the worker will have to retrace the logic used to design the control system commands in order to detect the incident

[77] It is worth noting that professional sociologists also developed similar views: see, for example, Pierre Naville, *Vers l'automatisme social?* (Paris: Gallimard, 1963); Id., *L'automation et le travail humain (Rapport d'enquête, France, 1957-59)* (Paris: CNRS, 1961).

that is actually preventing the machine from functioning".[78] Different kinds of diagrams which provided the operative with an abstract representation of how the equipment functioned – synoptic diagrams, kinematic chains or flow charts in the case of automation, or the so-called Castello method in the case of electrical breakdowns – were ceaselessly developed during this period by maintenance engineers for the purpose of providing workers with the information necessary for identifying the cause of breakdowns and then fixing these.[79] Without examining such diagrams in detail or analyzing the principles underlying their design, we wish to stress the engineers' attempts to codify and standardize breakdown repair practices in the electrical and automation domains by making these independent of the operators' subjectivity. "Breakdown repair manuals" were also developed containing step-by-step instructions to be followed in order to deal with a breakdown[80].

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[78] Pierre Henry (a maintenance engineer working for Kodak-Pathé), *in BTE. Journées d'information 1961*, p. 98.

[79] For an overview of these diagrams, see, Le Service Entretien. See also Pierre Castello, Clé des schémas électriques: étude logique des circuits et des automatismes (Paris: Dunod, 1965).

[80] Two examples of this eagerness to codify emanate from the iron and steel industry. "The purpose of the breakdown repair manuals is to enable *any electrician* [the italics are ours] to deal with a broken down machine rapidly and efficiently (...). If we exclude natural instinct or intuition, the only valid method for trying to resolve breakdowns is by process of elimination." (Chambre Syndicale de la Sidérurgie (henceforth, CSSF), *Organisation des services de l'entretien dans une usine sidérurgique*, (Paris, 1962), 2nd part, chapter 5, pp. 1 and 3. And, concerning automation: "Thus, breakdown repair operatives will successively place their devices on the test points indicated in the flow chart *without thinking* [the italics are ours], beginning at the end and following the correct order. When the abnormal situation recurs during the process, the breakdown will have been located (...)" (J.-P Schmit, "Les ordinogrammes", *Revue de Métallurgie,* 1972, LXIX: 541-552, on p. 552).

In the course of the 1960s, while work planning expanded by annexing new domains (electrical breakdowns, automation), it also had a more profound impact in the fields in which it was already present. A quantification movement took hold in maintenance workshops. During the 1960s, the qualitative approach of the preceding decade was actually grounded in quantitative terms; approximate solutions were transformed into quantified solutions. This is also the period in which more and more attention was paid to the "profitability" of work planning for maintenance operations (preventative maintenance, planning of breakdown repair work). Let us now examine the main features of this quantification movement.

We have already presented the reasons advanced by work planning advocates to counter the skepticism of those who insisted on the once-off, non-repetitive nature of their activities. During the 1960s, the proponents of work planning were able to enlist a plethora of statistics in support of their arguments. Thus, a "monthly analysis of four maintenance teams revealed that for each team (150 to 200 work slips), 40% of jobs were repetitive (2 to 13 times)". Another analysis of the work slips of a carpentry workshop revealed that "26 types of activity accounted for 4,943 hours of work out of a total of 18,200; the same analysis was conducted in a mechanical workshop, it revealed that only 25 types of jobs accounted for 8,026 out of a total of 19,200 hours".[81]

The same use of statistics that enabled engineers to highlight the repetitive nature of a significant portion of

[81] Le Service Entretien, p. 81; see also Jabot, Entretien et Travaux neufs.

maintenance activities also enabled them to defend the principle of work planning against those who challenged it on the basis of the urgency of the work in question: " if we use the work slips of any Maintenance Department to analyze response times, i.e., the % of work hours initiated in 1, 2, 3,...20 days, we get a curve (...) that proves that for the maintenance function, 60% to 80% of jobs are launched within a period that exceeds 48 hours. This makes it relatively easy to plan such jobs, if we so wish".[82]

However, these statistics do not merely demonstrate the possibility of planning maintenance activities. They also make it possible to "rationalize" such work by informing maintenance engineers if it is worthwhile from an economic point of view to carry out such planning work. Thanks to the use of the so-called Pareto diagrams or ABC analysis, engineers may choose the most "profitable" activities from among the various repair activities that it is possible to plan. The same concerns regarding rationalization led engineers to develop several instruments for use by maintenance work planners. The latter were provided with time lists corresponding to various maintenance operations.[83] Diagrams also made it possible to train the planners in adjusting the degree of planning in light of the expected results.[84] The work planner's judgment was also to be educated and controlled thanks to a series of practices: "Therefore, it is necessary to calibrate work planners' judgment over a period of at least

[82] Le Service Entretien, p. 79; see also Jabot, Entretien et Travaux neufs.

[83] R. Jabot, *Les temps de l'entretien CEGOS* (Paris: Editions Hommes et Techniques, 1968; first ed. 1961).

[84] Jabot, Entretien et Travaux neufs.

six months in order to correct their initial judgments. To do this, the work planner will have to mark the time allocated on a copy of the work slip, which is not transmitted to the worker, and to compare this to the time actually spent by the worker. All cases that show an excess of 10% of time allocated with respect to time actually spent must be investigated (...). Thus, work planner's 'degree of calibration' may be measured by counting the proportion of cases for which allocated time exceeds time actually spent by more than 10% (...)".[85]

The goal of economic optimization was also evident in research with the following aims: defining the optimal frequency for inspections and preventative maintenance operations with greater precision for different types of equipment; setting the optimal level for inventories of spare parts; optimization of work planning (introduction of scheduling techniques such as Program Evaluation Review Technique (PERT), from the US in the middle of the 1960s[86]). Although we do not have room here to provide a

[85] Ibid., p. 27. As the reflections of Jules Dupuit (1804-1866) of the *ponts et chaussées* engineering corps bear out, French engineers' wish to educate and control the judgment of implementers using various different mechanisms goes back a long way. See Konstantinos Chatzis, "Jules Dupuit, ingénieur des ponts et chaussées", in *Œuvres économiques complètes de Jules Dupuit*, 2 vols., Vol. I, eds Yves Breton and Gerard Klotz (Paris: Economica, forthcoming in 2009).

[86] PERT is a management tool first employed in the development of the US Navy's Polaris missile during the second half of the 1950s **(**see H.M. Sapolsky, *The Polaris System Development: Bureaucratic and Programmatic Success in Government* (Cambridge (MA.), Harvard University Press, 1972**)**. Concerning the introduction of PERT in French industrial engineering circles, see the journals: *L'Etude du Travail* (December 1963); *Revue Technique de l'Entretien et des Travaux neufs* (October 1966); *Achats et Entretien* (September 1966). Concerning the use of PERT in iron and steel factories in the 1960s, see: P. Bresso, "Méthodes de chemin critique: application pratique à un case", *Revue de*

detailed description of economic optimization techniques based on ideas such as the cost of breakdowns or the probability that a spare part will last, we should stress the transposition of results obtained based on mathematical analyses in the form of diagrams. Such transposition enabled factory personnel to automatically apply action programs defined by engineers.[87]

A new chapter in the maintenance rationalization project: sub-contracting

In the 1960s, a new dimension was added to the maintenance rationalization project: sub-contracting. The development of sub-contracting in Maintenance Departments was based on several arguments. Besides the traditional economic and technical reasons (increased efficiency due to the specialization of sub-contractors, possibility of

Métallurgie, 1972, LXIX: 561-577; R. Sadeler, "Méthodes de chemin critique: étude comparative", *Revue de Métallurgie*, 1972, LXIX: 553-558.

87 "Based on this method, low-level workers,(...) *automatically* apply [the italics are ours] the policy set by higher-level management if they follow the tables and do not feel they have to increase the level of inventories under the pretext that there is occasionally a shortage of spare parts" (*Le Service Entretien,* pp. 233-234). Concerning the application of operational research to the maintenance function, see Jabot, *Entretien et Travaux neufs,* pp. 97-98 and 367-421). One of the first books to appear in French dealing with operational research and maintenance is the translation of the work first published in English by P.M. Morse, *Files d'attente, stocks et Entretien. Analyse opérationnelle des systèmes à offre variable* (Paris: Dunod, 1960). See also, AFNOR, *La normalisation dans l'entreprise* (Paris: Editions AFNOR, 1967), pp. 169-175. Concerning the use of operational research in the maintenance function in iron and steel factories, see CSSF: *Gestion des stocks de pièces de rechange* (Paris, 1959) and *La standardisation du matériel et des articles de magasin dans une usine sidérurgique* (Paris, 1964). These methods were tested and subsequently applied in several factories (See Konstantinos Chatzis, "L'entretien dans la sidérurgie après 1950: de la fonction autonome aux groupes TPM", in *L'Autonomie dans les organisations. Quoi de neuf?,* eds K. Chatzis, C. Mounier, P. Veltz and Ph. Zarifian (Paris: L'Harmattan, 1999), pp. 188-206, on p. 192.

adjusting the number of maintenance operatives in line with the average workload, while charges were absorbed by the subcontractor at times of maximum load, etc.), there were also a number of other reasons worth mentioning here. Firstly, subcontracting offered an "excellent comparison with other corporations, which indirectly provides a means of subjecting the Maintenance Department of the firm in question to outside competition". The educational impact produced by the introduction of subcontracting is also far from negligible. In fact, one of the advantages of sub-contracting derives from the "awareness by foremen of the actual cost of various actions; when such actions were executed by the maintenance workshop, foremen frequently only had a vague idea of the cost. When they are provided with an estimate, they have a better idea and are frequently shocked at the price. They then try to find a less costly solution".[88]

Once the advantages of sub-contracting had been clearly spelt out, maintenance engineers examined the different forms of sub-contracting (daily rate, fixed rate, subcontracted labor, i.e., hired labor working under a factory foreman, etc.). Thus "a flat-rate formula is not advisable when operating in an unfamiliar domain".[89] The precautions to be taken when successfully hiring temporary staff and the advantages and drawbacks of hiring personnel from firms specialized in technical assistance were also formalized.

[88] Le Service Entretien, p. 264.
[89] Ibid., p. 268.

Tools to assist the head of the maintenance department in choosing between various options were also developed.[90]

The end of the 1960s up to 1975 : from "entretien" to "maintenance"

During the 1960s, French manufacturing facilities in several sectors constantly increased their production capacities while they were also subject to increased automation. This was particularly the case in the petrochemicals, steel and automobile sectors. Following a switch in the 1950s and 60s from coal to liquid hydrocarbon fuels, in 1968 petrol alone accounted for half of all consumption of primary energy sources in France. This period witnessed an enormous development of refining and petrochemical complexes and there were similar developments in the French steel industry where the State wished to create "national champions". The steel complex located at Usinor-Dunkerque, which was commissioned in 1963, had a capacity of 9 million tonnes by the end of the 1960s. In the automobile sector, the figures are just as impressive. French auto manufacturers built 500,000 vehicles in 1952; six years later they turned out 1,120,000 and the figure for 1970 was 2,700,000. In addition to these developments affecting French industry, we must also add the pressure to generate increased profits (financial logic) as French industry was subject to increased

[90] Jabot, Entretien et Travaux neufs, pp. 152-154.

competition from abroad.[91] Maintenance engineers sought to take account of such developments.

The fact that new facilities were "analyzed with regard to their useful life calculated in advance, in accordance with economic laws that fell within the scope of financial expertise" meant that "maintenance became indissociable from *management issues*" [the italics are ours].[92] A *technical-financial* logic was now added to the *technical-economic* logic of the 1960s. This new logic required that the maintenance function take account of the economic obsolescence of equipment (obviously, costly maintenance practices applied to equipment that will soon have to be replaced for economic reasons should be avoided). The appearance of two new terms both attests to and reflects the incorporation of the concept of the (economic) useful life of equipment into maintenance practices. While, up to the end of the 1960s, engineers used terms such as breakdown repair work, systematic maintenance and preventative maintenance, at the end of the 1960s they also began to use terms like *corrective maintenance* ("maintenance corrective" in French) and *remedial maintenance* ("maintenance palliative" in French). What do these terms mean? Corrective maintenance takes

[91] See, for example: Denis Woronoff, *Histoire de l'industrie en France du XVIe siècle à nos jours* (Paris: Editions du Seuil, 1998); Maurice Lévy-Leboyer ed., *Histoire de la France industrielle* (Paris: Larousse Bordas, 1996).

[92] J. Soland, "Entretien des installations d'automatismes", *Revue de Métallurgie*, 1972, LXIX: 529-539, on pp. 530-531. See also: Ch. Guyot, *Initiation à la maintenabilité* (Paris: Dunod, 1969); Institut français du pétrole, *La fiabilité au service de l'entretien et de l'inspection du matériel* (Paris: Editions Technip, 1969); P. Chapouille, *La fiabilité* (Paris: PUF, 1972); Introductory article in no. 400 of the journal *Achats et Entretien.*

place at the beginning of an equipment's useful life. Its purpose is to detect the modifications or improvements that must be made when the equipment is put into operation in order to keep costs down (maintenance costs + production stoppages), whereas remedial maintenance comes at the end of the equipment's useful life and consists of using the least costly means possible of allowing the equipment to function until it is finally taken out of service. Therefore, at the end of the 1960s, preventative maintenance, the major innovation of the 1950s, ceased to be applied to old equipment.

The developments in automation in the 1960s also attracted the attention of maintenance engineers. Indeed, automatic machinery is characterized by random behavior (unlike mechanical equipment, electronic equipment is not subject to wear and tear and, thus, it is difficult – or impossible – to predict when it is going to break down). In order to deal with the characteristics of the new equipment, maintenance engineers drew on *conceptual innovations; reliability* (the probability that a unit carries out given functions over a given period under set external conditions) and *conduciveness to repair* ("aptitude à l'entretien" in French; nowadays referred to as maintainability), i.e., the probability that a system, when in need of corrective or preventative maintenance, can be restored to a given state of functioning, within set time limits, when the work is carried out according to prescribed procedures and under given conditions".[93]

[93] The concept of reliability was first mooted in relation to submarine cables for which even basic repairs were either enormously expensive, as a ship

The emergence of the concepts of reliability and maintainability represented a watershed in rationalization as it applied to maintenance activities. These breaks with the past led French engineers to abandon the French term for maintenance in use until then, i.e., "*entretien*" (upkeep), in favor of "*maintenance*".

In fact, reliability and maintainability are properties that are defined to a large extent when the equipment is designed. Thence a redefinition of the relationship between the Maintenance and Engineering Departments was required. "For a considerable amount of time, the heads of Maintenance Departments had claimed that 80% of problems were rooted in the equipment design phase, however, their system, based on preventative maintenance, prevented them from taking effective action at this stage as they would have liked. However, '*maintenance*', which was considered an extension of reliability, requires complete integration of equipment design and use. Maintainability can only be guaranteed via steps taken during the project-design phase and the specific application of such steps during maintenance. Thus, '*maintenance*' would appear to be a way of providing those in charge of the maintenance function with the means of fully carrying out the activities for which they

had to be sent out to carry out such work, or frequently impossible. Reliability got a second wind in the French aeronautics industry in the mid-1960s thanks to the action of actors connected to the Centre National de Fiabilité within the Centre National d'Etudes des Télécommunications (CNET).

are responsible, both during the useful lives of the machines and during their design phase".[94]

The advent of automated facilities required close cooperation between the Engineering Department which designed the equipment, the Maintenance Department in charge of its operation, and the Department responsible for replacing it at optimal cost. All these departments were now involved in the maintenance operation. As a result, maintenance operations were no longer the "preserve" of a single actor, i.e., the Maintenance Department, but were disseminated throughout several institutional areas within the firm (Engineering Department…). From about 1975 on, the relationship between the Production and Maintenance Departments also evolved significantly. In fact the development of larger, more integrated machines, based on economies of scale and uninterrupted flows, meant that even the smallest breakdown had a major impact on the entire production cycle. Despite the more important role it now had to play, the Maintenance Department had a struggle to deal with these new realities. Indeed, the strict demarcation between manufacturing and maintenance which had prevailed since the 1950s became a serious source of inefficiency. As they were not permanently present in the areas of production and they did not have ongoing contact with given facilities, maintenance operatives gradually saw their perfor-

94 B. Hamelin, *Entretien et Maintenance* (Paris: Ed. Eurolles, 1974), pp. 18-19. See also: *Le service d'entretien. Méthodes actuelles de gestion*, Paris, Entreprise modernes d'édition, 1976; the translation from English of a classic work dealing with maintenance: V. Priel, *La maintenance. Techniques modernes de gestion* (Paris: Entreprise moderne d'édition, 1976).

mances deteriorate due to a lack of anticipation, excessively long lead times and the difficulty of providing rapid diagnoses. In order to cope with these problems, several French firms tried to redraw the functional carve-up (and compartmentalization) used in former years by an "inter-penetration" of the manufacturing and maintenance functions. Beginning in the 1980s, we witness the creation of "major operating units" combining the maintenance and manufacturing functions, giving rise to multi-functional operators responsible for both production and maintenance tasks. Mixed working groups were set up consisting of manufacturing operators and maintenance technicians for the purpose of ensuring optimal availability of facilities (the co-called "Total Productive Maintenance" (TPM) groups).[95]

At the end of the 1970s, the autonomy of the maintenance function was being challenged. The more central maintenance activities became to the functioning of the firm, the more the Maintenance Department as a distinct, specialized and wholly-responsible actor for a defined activity and guardian of appropriate tools and representations and of its own scientific management organization and strategies, experienced difficulties in carrying out these new maintenance tasks on its own. Thus, as regards both the maintenance function and large industrial firms as a whole,[96] the end of the *Trente Glorieuses* marked the

95 The author participated in a study of the functioning of such (TPM) groups in the iron and steel industry. See K. Chatzis, F. de Coninck and Ph. Zarifian, "L'argumentation dans le travail", *L'Année sociologique,* 1994, 44: 145-173; Chatzis, "L'entretien dans la sidérurgie".

96 We should stress that the developments which affected maintenance also impacted other functions in the firm, such as Quality control, Research

beginning of a new era in industrial rationalization which is still in search of a defining project.[97]

Conclusion

The aim of this article was to formulate a research program regarding the rationalization movement in French industry during the *Trente Glorieuses* (1945-75) and to offer a first example of such research, based on the maintenance function. Given that it concerns a program, such research will naturally require developments and extensions. We consider that these should be of two complementary types.

The first involves a direct extension of the historical perspective presented here. Firstly, we would like to map the rationalization practices developed within each function of the firm as completely as possible – including those deve-

and development and Engineering Departments. According to sociologists of work and organizations, large firms currently seek efficiency not by entrusting specialized actors (the engineers in various functions) with responsibility for rationalizing a specific field of industrial practice – i.e., the rationalization project that characterized the *Trente Glorieuses* – but by mobilizing several actors from different backgrounds and different levels in the hierarchy around cross-disciplinary issues (even low-level operatives participate, frequently against their will, in the search for new types of efficiency). The example of the Quality function, which is now the responsibility of all, and the setting up of new structures for action, such as project-based management, are a good illustration of this trend towards rationalization via integration and not via the development of specialized sub-projects.

97 For an overall view, see Veltz, *Le nouveau monde industriel*. Do these changes signal the end of all specialization-based approaches to industrial rationalization? We do not believe so. If we just consider the Maintenance function, we note that maintenance engineers are still organized in France in an association, now called AFIM (Association française des ingénieurs et responsables de maintenance) that publishes the journal *Production Maintenance*. However, based on the available evidence, all specialist "rationalizers" will have to liaise with other specialist "rationalizers" to a far greater extent than in the past.

loped within the maintenance function – given that the review presented in this article merely seeks to outline the related issues rather than to present an exhaustive account of the subject. By shifting the perspective from one function to another, the intention is to reconstitute the "specialized" rationalization projects which have characterized French industry during the *Trente Glorieuses*. Once the work in respect of each function has been carried out, we may envisage an analysis that deals with the various procedures underpinning the rationalization projects internal to each function taking place within the overall operating structure of the modern firm which, based on the results in respect of maintenance, is characterized by numerous conflicts and rivalries.

The second approach concerns specific firms. It involves studying the dissemination and implementation over time and within different sectors of industrial activity of such rationalization projects developed in technical literature and professional meetings (professional journals, manuals, study days, etc.). In order to do this, it is essential to carry out archive research, supplemented by interviews with the actors (engineers, as well as operatives) involved in in-house rationalization projects during the *Trente Glorieuses*.[98]

Before terminating, we wish to briefly discuss what might be described as a by-product of our research. In the course of their reflections concerning rationalization pro-

[98] We have already begun to carry out research into maintenance rationalization practices in the iron and steel industry. For the initial results, see Chatzis, "L'entretien dans la sidérurgie".

jects, engineers constantly refer to other actors within the firm (in particular, foremen and workers) whose activity – frequently described in negative terms – has also been the subject of rationalization. Indeed, technical literature, as we have seen in the case of maintenance, contains numerous comments concerning the attitudes, "passions" and modes of behavior of men and women in the workplace. However, these people exist in an "oral culture" and leave no written trace of their activities. Would it not be possible to use technical literature to record the history of "man in the workplace"? Obviously, this type of source refers to working people only indirectly, given that it is both written, and written by engineers. As such, these sources frequently act as filters and intermediaries who deform "reality". Nevertheless, even though they are not completely objective (what source is!), in our opinion, the thoughts and observations of engineers, when interpreted in a critical manner, may still provide precious information in respect of all those who help to make the wheels of industry go round.[99]

Acknowledgement: this article was translated from the French by Neil O'Brien

99 Concerning such questions, see Carlo Ginzburg, *The Cheese and the Worms. The Cosmos of a Sixteenth Century Miller* (Baltimore: The Johns Hopkins University Press, 1980; First ed. in Italian 1976); Alain Cottereau, "Etude préalable. Vie quotidienne et résistance ouvrière à Paris en 1870", introductory article in D. Poulot, *Le sublime ou le travailleur comme il est en 1870, et ce qu'il peut être* (Paris: Maspero, 1980; first ed. 1870), pp. 7-102.

From India to Brazil, with a microscope and a seat in Parliament:

the life and work of Dr. Indalêncio Froilano de Melo[1]

By Cristiana Bastos [*]

Indalêncio Froilano de Melo was born in Benaulin, Goa, on the 17th of May 1887. His was a traditional family of Brahmin, Catholic, and landed local aristocrats of the province of Salcete. Like many other Goan families, they had been Catholics for centuries, had Portuguese names and were at ease with official hierarchies; at the same time, they ranked highly in a social structure that still acknowledged caste status. Moreover, Indalêncio's father, Constâncio Francisco de Melo, was a lawyer, while his mother, Delfina

[1] The on-going analysis included in this article is part of the project *Empire, centers and provinces: the circulation of medical knowledge* (FCT PTDC/HCT/72143/2006) and benefits from earlier research conducted within the scope of the project *Medicina Colonial, Estruturas do Império e Vidas Pós-coloniais em Português* (POCTI/41075/ANT/2001), both funded by Fundação para a Ciência e Tecnologia and hosted by the Institute of Social Sciences, University of Lisbon.

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Rodrigues, came from a distinguished family; her father, Raimundo Venancio Rodrigues, from the Goan province of Bardez, had been a member of the Portuguese *Cortes* (Parliament) and mayor of the city of Coimbra.[2]

The picture of prosperity changed with the early death of Constâncio de Melo. Young Indalêncio was 12 years old at the time, and from then on he had to work hard on many fronts. He persevered and successfully passed through medical school. His career would be productive, unique, and versatile. He became one of the most famous Goan doctors ever; he combined clinical work, research and public health; he taught medicine, attended international conferences, directed medical services and headed the medical school. He was also deeply involved in local politics; he got to be the mayor of Pangim (1938-45), and represented India in the Portuguese parliament (1945-49). He participated actively in the debates of the time and had something to say about "overseas" politics, as he envisaged a transition from imperial connections to modern-style and diverse political federation that could restore dignity to the different peoples involved in the colonial nexus. This was too much for

[2] Biographical notes are compiled from Pedro Joaquim Peregrino da Costa, "Médicos da Escola de Goa nos Quadros de Saúde das Colónias (1853-1942)" *Boletim do Instituto Vasco da Gama, 57* (1943): 1-43, *58*:1-66; Américo Pires de Lima, "Froilano de Mello", *O Médico* 180 (1955) ; Artur de Oliveira e Silva, *Breve Contribuição da Escola de Medicina Portuense para o Estudo das Ciências do Ultramar* (Dissertation, Faculty of Medicine, University of Porto, 1964); Jose Collaco and Alfredo e Mello, "Professor Froilano de Mello, MD: A Short Biography of His Life and Achievements", *Goacom Biography Series* http://www.goacom.com/culture/biographies/froil1.htmal (access 11/11/2003); Francisco Monteiro, "Froilano de Mello (1887.1955)" *Galeria de Goeses Ilustres,* 2002 http://www.supergoa.com/pt/read/news_cronica.asp?c_news=159; as well as from oral sources collected in Goa, India, and São Paulo, Brazil.

Salazar's dictatorial regime: Froilano de Melo ended up out of place in a regime that had supported part of his political career. But neither did he fit into the politicized, anti-colonial opposition sympathetic to Indian nationalism, as epitomized by Tristão da Cunha and the freedom fighters. Froilano was unique to the end of his days, which he lived in a state of unofficial exile. He moved away from Portugal and away from Goa, away from the Portuguese colonies; he spent his time at the University of São Paulo, Brazil, away from politics, close to his beloved microscopes and to the microscopic subjects of research that meant so much for medical knowledge and for the health of millions.

The study of Froilano de Melo's life and work will help us understand the ways in which people and knowledge circulated within empire, not only geographically, or socially, but between different bodies of power-knowledge, between medicine and politics, between the laboratory and public health policies, between representations and practices, and between the so-called centers and the so-called peripheries. This study will also contribute to the understanding of the complex intertwining of imperial and local politics. Although much has been said on the topic, it is still insufficient to account for Froilano's multifaceted life. He personified the many layers of power and its contradictory stances. He was both a colonial subject and a highly cosmopolitan doctor. He admired Indian nationalism and he felt at home in Portugal. He moved easily within the Portuguese colonial structure which he understood as an expanded form of nationalism that could be restored into a federation of diversities from within. In many senses he was an in-between figure that

belonged comfortably to both worlds and ended up an outsider to both of them. Also, he was agency as much as structure; he acted on his own initiative in ways that no social structure could determine, while his life, persona, and work were also the product of a long-established, tense and contradictory society.

Froilano's career started with his graduation from the Medical School of Goa in 1908. Before going on, it is worth taking a minute to reflect on the interplay of medical institutions, medical teaching, colonial values, local values, social constraints and individual choices at the time. To study medicine in Goa, as opposed to Portugal, may be interpreted as a sign of the relative difficulties that Froilano experienced as a youth: those who had the choice and support would often go directly to the Portuguese medical schools in Lisbon, Porto or Coimbra. Some, too, chose to study medicine in Bombay.

Those who attended the Medical School of Goa had to face additional difficulties in order to pursue a medical career: they had to go through further training and exams in Portugal. Without this, they were left to do secondary jobs and could only take on second-class positions – *facultativo de segunda classe* – in the colonial health services, which included the remote outposts of Mozambique, Angola, Cape Verde, Guiné, São Tomé, Macau, and Timor. If lucky, they took positions within *Estado da Índia*, which included Goa, Daman and Diu. But they could not practice in Portugal, nor take the higher places in the colonial positions.

The subalternization of the Medical School of Goa within the Portuguese colonial system occurred at two levels.

Legal and political instruments downgraded its diplomas, and thus its graduates, stating they neither qualified to practice in Portugal, nor to fill the first-class positions in the outposts of Africa and Asia, where they could only take secondary positions. Ideology racialized them according to the hierarchies crafted by empires.[3] Portuguese colonial authorities used "evidence", clearly based on prejudice, in order to denigrate Indian doctors. Official reports about the Medical School emphasized the poor quality of its curriculum, the poor performance of the students, the absence of experimental learning and laboratory work; in sum, they depicted an establishment that could not qualify for the status of higher education.[4] Portuguese officers in charge of colonial health services depicted Indian doctors working under their supervision as inadequate and ignorant types who could not earn the respect of the patients.[5]

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3 Confidential reports are much more explicit about race than are official documents, suggesting that the prevailing racism was not fully coded, leaving room for ambiguities and free expressions of prejudice. In Froilano de Melo's obituary, his former class mate from the Medical School of Porto Americo Pires de Lima, trying to be complimentary, notes that "one could notice at the first sight an unmistakable air of race. As a matter of fact, he was of pure Brahmin caste, but perfectly Europeanized, a fine patriot." Claiming that everybody received Froilano openly, Pires de Lima considers that maybe not every single teacher did him justice, whether due to "unspeakable racial prejudice", or to "mistrust of a unknown migrant" (Lima, "Froilano..." (cit. n. 3)).

4 E.g., *Oficio,* July 11 1854, and *Ofício,* February 8 1856, from Eduardo Freitas d'Almeida, Head Physician, to Ignacio da Fonseca Benevides, President of the Navy and Overseas Health Council, Arquivo Histórico Ultramarino (Overseas Historicak Archive, hereafter, AHU), rm 12, Índia, Health Services, # 1987. For a lengthier analysis and discussion see C. Bastos, "Doctors for the Empire : The Medical School of Goa and its Narratives." *Identities* 8 (2001) : 517-548; "Medicina, império e processos locais em Goa, século XIX." *Análise Social 182* (2004): 99-122.

5 *Relatorio do serviço de saude da província de Moçambique, 1893,* José d'Oliveira Serrão d'Azevedo, Arquivo Histórico Ultramrino, Sala 12, maço 2817; for discussion see, C. Bastos "O Médico e o *Inhamessoro*: O

Far from being passive recipients of their subordination, Goan doctors fought back. The book *Médicos Ultramarinos,* by Dr. Sócrates da Costa, reads like an anti-discrimination manifesto.[6] They fought for better jobs, better training, equal opportunities – or, at least, equal to those held by the Portuguese. Equality was not a universal aspiration – factions, frictions and fractures abounded, and different hierarchies co-existed. No single agenda emerges from Goan doctors' reactions. Different things were voiced by different people at different times. Because many of the graduates ended up serving for some time in Africa, as this was one of the few career opportunities offered to them, it is interesting to analyse the ways they shaped colonial categories in a relational manner. Once hierarchized, and not placed at the top, they wanted to make sure someone else ranked below them, be it the lower castes back home or any African they met.

In 1879, for instance, the young Arthur Gama, a recent graduate of the Medical School of Goa, found himself as the sole representative of the colonial government in the

relatório do goês Arthur Ignacio da Gama em Sofala, 1879" in *A persistência da história* , ed. C. Carvalho & J. Pina-Cabral (Lisbon: Imprensa das Ciências Sociais, 2004), 91-117; "Race, medicine and the late Portuguese empire: the role of Goan colonial physicians" *Journal of Romance Studies, 5* (2005): 23-35; "Medical Hybridisms and Social Boundaries: Aspects of Portuguese Colonialism in Africa and India in the Nineteenth Century" *Journal of Southern African Studies, 33* (2007): 767-782.

6 Aleixo Justiniano Sócrates da Costa, *Os Médicos Ultramarinos: Mais um brado a favor dos facultativos formados pela Escola Médico-Cirurgica de Nova Goa* (Lisbon: Tip. Universal, 1880). For a discussion, see also C. Bastos, "The inverted mirror: dreams of imperial glory and tales of subalternity from the Medical School of Goa." *Etnográfica, VI* (2002): 59-76.

very remote post of Chiloane island, in Sofala, Mozambique.[7] He wrote the official reports using the imperial "we"; he sided with the Portuguese and was unsparing in his use of words of deprecation against what he considered the primitive and savage ways of the Africans whose lives he was supposed to rule over.[8]

A few years later, in 1889, the Goa-born and Lisbon graduate doctor Rafael Pereira, heading the Health Services of *Estado da Índia* at the time, theorized at length about the role of Indian physicians as intermediaries between the Portuguese and the Africans.[9] His rationale seemed to be that if they could not hold the same status as the Portuguese, they could come nearer to it by contributing in unique ways for the consolidation of empire.

Decades later, another Goa-born doctor and researcher, Germano Correia, used every possible opportunity, in his many papers on physical anthropology, history of medicine, or history of colonization, to make public statements against the discrimination of Goans within the Portuguese colonial system. But his protest did not really encapsulate an early anti-colonial consciousness of emancipation, and much less an egalitarian ideology. His fight could better be depicted as a personal pursuit of a group identity that could spare him from the derogatory contamination of being lumped

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7 *Relatório da Ilha de Chiloane Capital de Sofalla*, apresentado pelo facultativo da 2.ª classe em Comissão do Quadro de saude de Moçambique, Arthur Ignacio da Gama, 1 de Janeiro de 1879. *AHU*, rm 12, Health Services, Mozambique, # 1506.

8 See Bastos, "O médico", "Race…", "Medical Hybridisms…" (cit. n. 5)

9 *Relatório do Seriço de saúde da Índia,* October 30, 1889, by Rafael António Pereira. AHU, rm 12, # 1988.

with the natives – the generic "barefoot marahta" he so much abhorred.[10] His vast work about "Luso-descendants" – a category that served the purpose of re-classifying its members as Europeans – seems like a long effort to rescue himself from the feelings of misplacement and displacement experienced as a colonial subject.[11]

On those matters, too, Froilano was unique. He did not fight for a special status of inclusiveness within Portuguese circles. He circulated through different social spheres for most of his life, owing to personal merits; his cosmopolitanism transcended the circles of empire. He claimed loyalty to Portuguese rule while praising Indian culture. He did not feel compelled to choose between one and the other. Instead, his energies were dedicated to the more universal goals of promoting health, life and dignity.

In order to understand this doctor's place in society one should try to grasp a closer and nuanced perception of Goa's social stratification, which I suggest seeing as complex entanglements of dissonant – and sometimes contradictory hierarchies. Goa's society accounted for several simultaneous hierarchies of value; and while Froilano de Melo and his peers might be de-valued in a racialized colonial order, they

[10] Germano Correia, "Os Luso-descendentes de Angola: contribuição para o seu estudo antropológico" *Memória do III Congresso Colonial Nacional.* (Lisbon: Sociedade de Geografia/Tipografia Carmona, 1934), 57.

[11] C. Bastos, "Um luso-tropicalismo às avessas: colonialismo científico, aclimação e pureza racial em Germano Correia", in *Fantasmas e Fantasias Imperiais no Imaginário Português Contemporâneo*, ed. M. C. Ribeiro and A. P. Ferreira (Porto: Campo das Letras, 2003), 227-253; Bastos, "Race…" (cit. n. 5).

ranked very highly in a wider system of interacting political agendas, within which the Portuguese and their politics were only one small part. This picture is drawn mostly from the analysis of primary sources, as there are, so far, only a few analytical works that cover Goa's nineteenth and early twentieth society.[12] But primary sources are rich enough to enable us to grasp the sense of disconnectedness experienced by those who were in charge of running the place. They could not run it properly, as they had to deal with obstacles that were thrown up by local political interests. This was precisely at the core of the complaints of the Portuguese placed in head positions in India. They constantly lamented their inability to implement any rules unless they matched the agendas of the local delegates. Officers seemed puzzled by those contradictions and paradoxes. Some of them seemed to despair of the difficulties, while others conformed to the state of things as they were and tried to adjust themselves accordingly. In sum, some of the local groups, or individuals, had a higher share of power than the Portuguese formally acknowledged. Although this picture may conflict with established views about empire, it should come as no surprise to those acquainted with Portuguese colonial history in a wider perspective. Connections to India had been in decline since the 17th century; at that time, trade shifted to the Atlantic. Not that *Estado da Índia* ceased to be a Portuguese colony, but fortunes, gold, trade and plantations were all to be made

[12] There have been some recent works that fill the gap and raise important questions, most notably Rochelle Pinto *Between Empires: Print and Politics in Goa* (Delhi: Oxford University Press, 2007).

in Brazil and in close tandem with the slave trade in Africa. After Brazilian independence, in 1822, there was a sort of intermezzo in Portuguese imperial politics, and only after the Berlin conference (1884-5) were there systematic attempts to build empire in Africa. In those circumstances, much of what happened in Goa, and, for that matter, in Asia, was not really at the center of Portuguese colonial interests. Yet local life went on, with its politics, its passions, its accomplishments.

The fact that a colonial institution like the Medical School of Goa was founded there in 1842, fashioned after the medical schools of Lisbon and Oporto, and created to teach western medicine to local students, should not be taken as a sign of colonial intervention but as its very opposite: regardless of the fact that the school was later appropriated by the narrative of imperial pride, primacy and longevity, its foundation should be associated with the action of local elites with the cooperation of Portuguese delegates in place, rather than linked to an action of the metropolis aimed at the promotion of western medicine in the colonies.

As a matter of fact, the school opened its doors in 1842, the year when the capital of *Estado da Índia* had moved to the city of Pangim, temporarily named Nova Goa, in the district (*Taluka*) of Ilhas. In the local historiography that developed a century later, credit is given to Mateus Moacho, the Portuguese Head Physician, together with the Count of Antas, who was then the governor and signed the local *portarias* that established the new Medical School. Dr.

Moacho is celebrated as the founder and visionary who was able to start what others had attempted and failed.[13]

And yet Mateus Moacho was only passing by. He and the Count of Antas left India the following year. We have no evidence that Moacho had a plan for the teaching of western medicine as a tool for the expansion and consolidation of colonial rule. And, indeed, there is no reference to the Medical School of Goa in Portuguese legislation until 1847.

There is an earlier reference to medical teaching in India in the 1844-45 legislation, which is taken by interpretters like Peregrino da Costa as the delayed approval of the Medical School.[14] And yet in that set of laws, regulating the colonial health services and determining that colonial hospitals should provide medical training to local populations, does not differentiate India from Mozambique, Angola, and Cape Verde.[15] That fact is also noted by Meneses Bragança in his 1923 overview of education in India. From his perspective, the absence of the briefest reference to the Medical School of Goa in the 1844-45 legislation regulating medical teaching in the colonies meant that the Portuguese government did not acknowledge the school. Moreover, he suggested that it had mostly resulted from "a creation of the local

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13 Germano Correia, *História do Ensino Médico na India Portuguesa nos secs. XVII, XVIII e XIX* (Bastorá: Rangel, 1947); João Pacheco de Figueiredo, "Escola Médico-Cirúrgica de Goa: Esboço Histórico". *Arquivos da Escola Médico Cirúrgica de Goa*, serie A, *33* (1960): 119-237; José Antonio Ismael Gracias , "Fisicos-Móres da India no Seculo XIX. – Memoria historica", *O Oriente Português XI* (1914): 255-278; for a discussion, see C. Bastos, "O ensino da medicina na Índia colonial portuguesa: fundação e primeiras décadas da Escola Médico-Cirúrgica de Nova Goa" *História, Ciência Saúde – Manguinhos, 11* (2004): 11-39.

14 Peregrino da Costa "Médicos..." (cit. n.2)

15 See Bastos "Doctors..." (cit. n. 5), and "Fundação..." (cit. n. 13)

government which the metropolitan government had refused to subscribe". He furthermore noted that the governor Garcês Palha, who followed the Count of Antas, had honourably authorized the continuation of the establishment, in spite of Lisbon's lack of support.[16]

In spite of what Lisbon approved or ignored, things were happening in India on the medical teaching front, while they were not happening anywhere else in the colonies. Brazil, which had two medical schools, was no longer a colony, and people now went on with their lives without the jurisdiction of the Portuguese government. In Goa they were under that jurisdiction, but they did not seem to follow every word of it. Regardless of the (lack of) response of the Portuguese government to their initiative, Goans enrolled in the new medical school. Among them were Pedro Gonzaga Augusto de Melo and Felizardo Piedade de Quadros, from Raia, Salcete, Luís Francisco Fremiot Conceição, Francisco Xavier Lourenço, Agostinho Vicente Lourenço, and António Luís Moreira, all from Margão (Salcete), plus Joaquim Lourenço da Anunciação Piedade Araújo, from Loutolim (also Salcete), and Bernardo Wolfango da Silva, from Piedade (Ilhas). They graduated in July and August 1846, that is, before the Portuguese government even acknowledged the existence of a Medical School in Goa.

Their school was not richly endowed. They counted on existing military hospitals in Ribandar and Pangim, and used the building of the Maquineses Palace for the rooms

[16] Menezes Bragança, "A Educação e Ensino", *Índia Portuguesa 2* (1923).

that served as medical library, an anatomical dissection room, and a chemistry laboratory; they counted also on the good will of a very small number of teachers. Among them was Mateus Moacho, followed by Francisco Maria Torres, plus the army surgeons J. Frederico Teixeira Pinho and António José da Gama – who was among the first Goans ever studying abroad, on a scholarship – and by António Caetano do Rosário, who had no scholarly training and had learned medicine by working in the hospital.

And yet students persevered, got their training, their licences, and created a collective entity that gave them a qualified scholarly identity, one that for years to come would produce more and more graduates, not without getting into decades of difficulties with the Portuguese administration and, later, being re-interpreted as something that was all along planned by the Portuguese.

I suggest that, against the official historiography that developed along the twentieth century – much of which was due to the efforts of Germano Correia[17] – that we should ground the Medical School of Goa in local agency, local interests, and local will to adopt, at least partially, the language, knowledge and perhaps the practices of western medicine for some purpose, be it the actual practice of medicine or merely the achievement of higher education credentials that could lead to better places in the administration.[18]

[17] Correia, *Historia;* Figueiredo, *Escola* (cit. n. 13)

[18] For a very interesting analysis of a parallel situation in Bombay – where rich Parsi merchants supported the earlier western hospitals in the 1830s – see Mridula Ramanna, *Western Medicine and Public Health in*

Froilano de Melo, too, got his training in Goa, and the remainder of his life indicates that he was seriously committed to medicine. After graduating in 1908, he continued his studies at the Medical School of Oporto, where he graduated in 1910 with the dissertation *Introdução ao estudo das febres de Goa – uma página da patologia colonial (Introduction to the study of Goa's fevers – a page on colonial pathology)*.[19] He was immediately named third-class physiccian in the health services of India with the military rank of *alferes-médico*. He moved up fast in the medical-military hierarchy and became lieutenant in 1912, captain-major in 1914, major in 1920, lieutenant-colonel in 1924, and colonel in 1927. He got involved in public health, medical research and medical teaching of all possible types.

Already in 1911, young Froilano de Melo was part of the committee formed for the reform of public health in the colony and was also the interim director of the vaccine institute. That was the year of a bubonic plague epidemic in the harbour of Mormugão, and Froilano could show, as the official delegate to fight the epidemic, his commitment to organized public health measures. His work attracted laudatory official remarks, which were repeated in 1914 for his action in the province of Salcete. His commitment to sanitary action continued throughout his life. We can suggest that he became the ultimate biopolitician of Pangim, as one who at once governed and watched over the collective body and

Colonial Bombay, 1845-1895 (Dehli: sangam Books-Orient Longman, 2002).

19 Peregrino da Costa, "Médicos... (cit. n. 2); Oliveira e Silva *Breve Contribuição* (cit. n. 2)

individual bodies, as well as over animal bodies and the invisible bodies that threatened them. For that matter he watched over nature as well – over the air and the waters, wells and sewage, river mouths and benches, harbours, dwellings, pavements, and constructions. Malaria was one of his early interests; in 1914 he presented his research both at the sanitary conference of Lucknow and at the first sanitary conference ever organized in Goa, promoted by himself in that same year. In that conference he presented a few papers on malaria, smallpox, vaccines, immunity, ankilostomiase, cholera and public health. In 1917 he was lobbying for the construction of a network of canals in the city. In 1923 he coordinated field research on water wells and anopheles mosquitoes that led to anti-malarial preventive policies. Epidemic outbreaks mobilized him for immediate action, but the prevailing endemic diseases interested him too. In 1928 he created a sanatorium for Tuberculosis in Margão, and in 1932 a Leprosarium in Macasana. He directed the bacteriological institute between 1914 and 1945, and in 1938 he became the mayor of the city of Pangim. He remained in the job until 1945, when he was elected to the Portuguese parliament. As mayor he could implement public health, and biopolitics, on a wider scale; not only upon human beings, but also upon dogs (rabid dogs were slaughtered), upon trees (jacarandas and acacias from Cuba were planted), upon stones, constructions, places, and spaces.

He was, indeed, a powerful man, and one whose passion and life were driven by a strong belief in the redemptive powers of biomedicine. He never ceased studying and teaching. Already in 1920 he gained official support to pur-

sue his specialization in tropical medicine and obtained a licence to go to Lisbon, Paris, London and Berlin. In 1921, he inaugurated the course of mycology and protozoology in the medical school of Oporto, where he taught parasitology and pathology as visiting lecturer. He also pursued his studies in parasitology in Berlin.

He was in the medical faculty for most of his life. He taught a vast array of subjects at the Medical School of Goa, including General Pathology, Bacteriology and Parasitology, Descriptive and Topographic Anatomy, Physiology, Histology, *Materia medica* and Pharmacology and, for the first time, Microbiology and Tropical Pathology, which he inaugurated as early as 1913. In 1925, after returning from a series of periods of advanced training in Europe, he became director of the Medical School of Goa and held the job until 1947.

His role in the shaping and circulation of medical knowledge can be assessed by his numerous participations in major conferences, his publications, his membership in international scientific societies and, last but not least, his involvement in editorial boards of scientific journals. As early as 1912 he was the head editor of the journal *Revista de Medicina*. He was also among the founders of the *Boletim Geral de Medicina*, the *Arquivos Indo-Portugueses de Medicina e Historia Natural*, and the most renown *Arquivos da Escola Medico-Cirurgica de Nova Goa*. He published on leprosy, malaria and other topics of tropical medicine and parasitology, alongside with public health.

He was a member of several international scientific societies: the Royal Asiatic Society of Bengal, the Indian

Academy of Sciences, in India; the Societé de Pathologie Exotique and Societé de Biologie de Paris, in France; the Sociedade de Etnologia & Antropologia, in Oporto, and the Sociedade de Ciências Médicas and the Sociedade de Geografia de Lisboa, both in Lisbon, Portugal.

The list of medical conferences he attended as a representative of Portugal is impressive – "endless", according to his obituary by Américo Pires de Lima, or precisely 37, according to a recent biographical note.[20] That included, in his mid-20s, the All India Sanitary Conference and the Third Entomological Meeting, both in Lucknow, 1914, where he lectured on the very recently formed field of medical mycology by invitation of the Viceroy. He was the delegate of Portugal in places as diverse as Lahore in 1918, Coimbra in 1925, Calcutta in 1927, Cairo in 1928, Allahabad in 1930, Algiers in 1930, Padua in 1930, Oporto in 1931, Jujuy in 1931, Bangalore in 1932, Bucharest in 1932, Lisbon in 1935, Amsterdam in 1935 and in 1938, Orense in 1935, Budapest in 1935, Lausanne in 1935, Paris in 1937, Lourenço Marques in 1938, Johannesburg in 1938, and Havana 1949. In 1950 he was invited to Petropolis by the Brazilian ministry of health, for he had lost support from the Portuguese government. Earlier, besides representing Portugal abroad, he had been part of the scientific intelligentsia that brought to life the celebratory centennial of 1940.[21]

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[20] Pires de Lima "Froilano de Mello"; Collaco & Mello, "Professor Froilano de Mello..." (cit. n. 2)

[21] For a thorough analysis of the scientists' participation in the 1940s centennial celebrations, see M. Fátima Nunes "The History of Science in Portugal (1930-1940): The sphere of action of scientific community", *e-*

He also served in Africa as part of his military-medical career. In 1922 he directed the Office of protozoology and mycology of the Institute of Scientific Research of Luanda, Angola, which he left in 1923 and returned to in 1925 for a conference about Tropical Medicine in Western Africa, where his work – together with that of his colleague Germano Correia – was highly appreciated and deserved the acknowledgment of the Portuguese republican government – soon to be replaced by Estado Novo.[22]

A note should be made on the popularity of Froilano at the time, which led him to win the elections to represent Goa in the parliament – against the opposition of the church, who accused him of being a freemason.[23] However, those elections did not lead to a parliament, for the 1926 military coup put an end to the republican regime. It would take another twenty years before there were new elections.

Froilano's experience in Africa helped him shape the celebratory speech addressed to the alumni, faculty and authorities during the centennial celebrations of the Medical School of Goa that took place in 1942. He mentioned his brief acquaintance with the "dark continent", and his experience of being made welcome in the places where the natives were suffering, rich and poor alike, after which he draw

journal of Portuguese History 2 (2004) http://www.brown.edu/Departments/Portuguese_Brazilian_Studies/ejph/html

[22] The Goan paper *A Índia Portuguesa* of May 23, 3004, reported the appraisal note given by the Portuguese Republican Government to Froilano de Melo and Germano Correia, both professors at the Medical School of Goa, for their valuable contributions to the Tropical Medicine conference.

[23] See discussions in *A Índia Portuguesa* 3028, Nov 14, 1925, on p.3, and *O Bharat* XI (51), March 24 1927, on p.2.

conclusions about the general appreciation of Goan doctors in the Portuguese colonies.

Knowingly or unknowingly, Froilano's voice was at that moment in tune with the Portuguese government, even if only momentarily. Finally, Goan doctors were acknowledged by the Portuguese administration, maybe less as an effect of their pleading than by the fact that there was a new agenda for the Portuguese colonial governance. Now, they were useful for symbolic and material purposes; they were tokens of diversity, of educated colonial subjects, and they could indeed be used as qualified clinical labourers in Africa. In 1942, Goan doctors could look back at their collective past and see a purpose on their African trajectories. They now saw themselves as pillars of empire, regardless of the fact that they had been so poorly treated by the Portuguese authorities all through their collective history. Such was the tone of the celebratory events of 1942.[24]

Things had changed since the times they were fighting for acknowledgment in a colonial order that despised them. The history of the Medical School of Goa was then rewritten. The 1942 celebrations of the Medical School of Goa centennial were also a reverberation of the 1940 large colonial exhibit in Lisbon *O Mundo Português*; and they also celebrated the tricentennial of the 1640 "restoration" of independence from Spain. *Empire* equated to *Nation*.

[24] Escola Médico-Cirúrgica, *Comemorações Centenárias (1842-1942)* (Bastorá: Tipografia Rangel, 1955); C. Bastos "Goa em 1942: A retórica do império e as ambiguidades do nacionalismo" in *Portugal não é um país pequeno: pensar o império na pós-colonialidade*, ed. M. R. Sanches (Lisbon: Cotovia, 2007), 229-247.

Colonial institutions became central to the rhetoric of nation, and some of the pre-existing ones were given a prestige that they might not even have had in the beginning. Along those lines, the Medical School of Goa was celebrated as a pioneering institution created by the Portuguese in Asia, and Goan doctors trained there were celebrated as heroes and pioneers of Portuguese medicine in Africa.[25]

Froilano de Melo participated to the full in those celebrations. He had been a student, faculty member, and director of the institution. He had been involved on many different fronts in the field of public health, either by promoting sanitation, fighting epidemics or implementing prevention. In many senses he was a politician while doctor and a doctor while politician. During the centennial, he was also the city's mayor and in a few years he would be elected to the parliament as deputy, and was able to fulfil his mandate between 1945 and 1949.

In the 1940s Froilano seemed well in tune with the wider political power that governed his surroundings, and he moved easily between places. In the Lisbon parliament he often presented himself as a doctor who diagnosed ailments and suggested appropriate treatments, and that included social, economic and political situations and interventions. In those terms he often spoke of his native Goa, at that time mostly referred to as simply "India", or "Portuguese India". One of the issues of concern for Goans was the fact that their social status had been lowered under Salazar's legislation,

[25] Escola Médico Cirúrgica, *Comemorações*

against a long established practice of granting them a special status. Informally acquainted for a long time with the higher spheres of power, and actually involved with decision making in matters concerning them, Goans did not welcome being treated as mere natives and colonial subjects.

Without showing any hostility to Salazar's government, and emphasizing his loyalty to Portugal, Froilano addressed with some objectivity the tense situation experienced in the wider India on the eve of its independence, and noted its potential to affect Goa. He also suggested that a lusophone confederation could restore the dignity aspired to by Goans without challenging the Portuguese rule.

Those ideas were not embraced by Salazar, who, in the aftermath of WW2, was heading in the opposite direction to the one of most European nations regarding democratization and decolonization. As recent scholarship has shown, only at that time was the Portuguese government about to implement some consistent colonization policies, which attracted crowds of colonists to Angola and Mozambique as late as the 1950s, 60s and early 70s![26] What had been mostly a celebratory style of empire, as epitomized by the 1930s and 1940s exhibitions, was about to be replaced by a more "modern" approach to colonization; however, that occurred at a time when most European colonial empires were collapsing and giving way to other social-political formations.

Under Salazar, discussions about decolonization, confederation or colonization styles were not supposed to occur,

[26] Cláudia Castelo, Passagens para África. O Povoamento de Angola e Moçambique com Naturais da Metrópole (Porto: Afrontamento, 2007)

whether in the Parliament or in the streets. Moreover, the regime engaged in a sort of ideological engineering by adopting the doctrines of Gilberto Freyre on Portuguese colonization, at some point named lusotropicalism. Freyre was a Brazilian sociologist-anthropologist who had theorized about the benign and creative style of the Portuguese colonization – as opposed to the Northern European version – in his masterpiece about Brazilian north-eastern plantation society, *Casa Grande & Senzala*.[27] According to him, the Portuguese were less racist and more amiable in their interactions with colonized peoples than other European colonizers were. Invited by a minister of Salazar to elaborate further on Portuguese colonialism with an actual visit to the African and Asian colonies, Freyre engaged in such a visit in 1951-2, after which he published *Aventura & Rotina* and *Um Brasileiro em terras portuguesas*.[28] The former, written like a travelogue, lets us see inside his reflective mind and its many contradictions. More interesting to us is the way he recorded his main insight about lusotropicalism, and the very formulation of the term. It actually happened in Goa, during a conference at the Vasco da Gama Institute, in December 1951. Freyre was deeply impressed with what he found to be similar between exotic Goa and his Brazilian homeland. Besides the elements of the natural environment,

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27 Gilberto Freyre, *Casa Grande & Senzala* .(Rio de Janeiro: Schmidt, 1933).

28 Gilberto Freyre, *Aventura e Rotina*. (Rio de Janeiro: José Olympio, 1953); *Um brasileiro em terras portuguesas* (Rio de Janeiro: José Olympio, 1953).

there were artifacts, customs, tastes, pieces of knowledge that both places seemed to share – in sum, there was somehow a shared culture that could only relate to a common history under Portuguese influence.

It did not take long for the Portuguese official endorsement of lusotropicalism as a basis for the justification of their increasingly anachronistic colonial rule in Africa and Asia. That happened in 1961, when Freyre's *O Luso e o Trópico* was published in three languages in the context of the Henry the Navigator 5th centennial celebrations; the work provided the wording for official discourse abroad and within borders.[29]

At that time, in the very year of *O Luso e o Trópico,* Goa had become part of the Indian Union, through a process that some refer to as liberation and others as invasion.[30] That year, too, the nationalist guerrilla war started in Angola. The ideological engineering that promoted lusotropica-

[29] Gilberto Freyre, O Luso e o Trópico: sugestões em torno dos métodos portugueses de integração de povos autóctones e de culturas diferentes da européia num complexo novo de civilização, o luso tropical (Lisboa: Comissão Executiva das Comemorações do V Centenário da Morte do Infante D. Henrique, 1961); simultaneously published in French and in English as Les Portugais et les tropiques: considérations sur les méthodes portugaises d´intègration de peuples autochtones et de cultures différentes de la culture européenne dans un nouveau complexe de civilisation, la civilisation luso-tropicale (Lisbon, Commission Exécutive des Commémorations du V Centenaire de la Mort du Prince Henri, 1961); The Portuguese and the Tropics: Suggestions Inspired by Portuguese Methods of Integrating Autochthonous Peoples and Cultures Differing from the European in a new, or Luso-Tropical Complex of Civilisation (Lisbon, Executive Committee for the Commemoration of the Vth Centenary of Prince Henry the Navigator, 1961).

[30] Maria Manuel Stocker, *Xeque mate a Goa*. (Lisbon: Temas e Debates, 2005).

lism had no real counterpart in a society marked by tensions and conflicts that lasted for another decade, until 1974, with Portugal stubbornly engaged in African colonial wars and still considering the territories of Goa, Daman and Diu as "overseas provinces."

To none of this was Froilano de Melo a direct witness. I am not sure whether he ever came across the word "lusotropical". At the time Freyre supposedly first uttered it in public, at the 1951 Vasco da Gama conference in Goa, Froilano de Melo was no longer in India. He was then living in the metropolis of São Paulo, Brazil, and there he remained until his death in July 1955.

What had brought this highly valued Goan scholar to Brazil in the 1950s, where he remained apart from the emerging Portuguese colonial politics that ended up promoting lusotropicalism as an ideology but turned away from any trace of confederation of the sort Froilano advocated? Some of Froilano's obituaries refer to a lack of appreciation by his fellow Goans in the final years of his life. Brazil appeared like a place of exile where his merits had been acknowledged; there are suggestions that he taught at the University of São Paulo, like the one who receives abroad the acknowledgement he fails to get at home.

In 2003 I searched for traces of Froilano's period at the renowned University of São Paulo (USP). I found out that he had been working at the laboratory of the celebrated Brazilian parasitologist Samuel Pessoa. Knowing that the latter had been a member of the communist party, and that Froilano de Melo was somehow outside the appraisal of the conservative Portuguese regime in the 1950s, I wondered if

our doctor had veered significantly towards the left. Although plausible, there was not a shred of evidence about such a move – and indeed there had not been one. I came to learn about it via a direct witness, his son, whom I met by chance and thanks to the good-will of USP clerks, plus a surprisingly efficient phone directory for the city. Although Indalêncio was not on the records of USP – which means he never took a formal job there – there was one Victor Froilano Bachmann de Melo, a former professor of engineering. A long-time resident of São Paulo and a prominent civil engineer, Victor generously received me at his home and provided valuable pieces of oral history about his father and family.

I learned that the connection between Samuel Pessoa and Froilano de Melo had been more of a bench scientists' comradeship than a political one. Froilano de Melo´s politics remained quite idiosyncratic and he was not truly backed by an ideological option structured by the left-wing parties. His commitment to the promotion of the dignity of Goa and rights of Goans was framed as a political project that, in his understanding, could be presented within a parliament that was almost totally supportive of the regime. He did not speak like an activist, but like any other parliamentary member. His speeches in Parliament, between 1945 and 1949, were often applauded by the other members, who were almost exclusively people in Salazar's confidence. The only time his words were not applauded was when he considered himself to blame, due to personal inaptitude, for not having fulfilled

one of his political goals in the parliament.[31] And yet even his modest proposal for more dignity and autonomy for Goa was not accepted by Salazar's regime. He lost the support he had counted on for most of his life, the one that made him representative of Portugal at many international conferences.

Froilano de Melo was too out-of-place in Salazar's regime and, for that matter, in the growing tensions that swept through Goa and Goan loyalties throughout the 1950s. He was a cosmopolitan scientist, one that had gone around the world and could keep doing so. He actually had some of his children in Brazil – not due to ancient colonial connections, but due to their own cosmopolitanism. Froilano had himself envisaged the post-WW2 scenario of an increasing predominance of the Anglophone world, contrasting with the Francophone high culture he was so intimately acquainted with; and he encouraged his children to go for higher education in Anglophone countries. After graduating from the U.S. and Canada, some of them chose to live in the vibrant society of Brazil, where the paradigm of modernization and rapid growth encouraged the placement of highly qualified engineers and scientists. Among them was the Goan-descended, MIT-trained, Portuguese-speaker and definitely cosmopolitan Victor de Melo.

Along with projects for growth and progress, some in Brazil attempted to make up for lost time and ease the pains of social and sanitary underdevelopment. Out of this grew an

[31] The interventions of Froilano de Melo in the Portuguese Parliament between 1945 and 1949 can be consulted in full in the online archives for *Assembleia Nacional (IV legislatura)*.

important sector of public health, social medicine, and a locally appropriate biomedical knowledge that accounted for laboratories like the one headed by Samuel Pessoa, where Froilano de Melo finished his working days. His route to São Paulo had been that of a cosmopolitan scientist that moved along some of the pathways that his own life created; as a passionate researcher in parasitology and microbiology in general, he felt at home near a microscope, and by the microscope he worked until the end.

Publications by Froilano de Melo

1910 *Introdução ao Estudo das Febres de Goa (uma página de Patologia Colonial)* (Oporto: Tipografia a vapor da Enciclopédia Portuguesa Ilustrada).

1911 *Contribution à l´étude de la pneumonie pesteuse de Childe* (Paris: *Presse Medicale).*
"Febres Remitentes da India (estudos combinados de Clínica e Instituto Bactereológico)-Observações clínicas do Dr. J. Peregrino da Costa (Parat B) e Dr. Augusto de Rego (Eberth)", *Bol. Ger. De Med. e Farmácia* (Nova Goa).
"Febres Remitentes da India (estudos combinados de Clínica e Instituto Bactereológico)-Obs. Clínica do Dr. Siqueira Nazaré (Parat. B)", *Bol. Ger. De Med. e Farmácia* (Nova Goa).
"Febres Remitentes da India (estudos combinados de Clínica e Instituto Bactereológico)-Um caso de tifoide complicada de peritonite de Therial. Obs. Clínica de José Maria Pantaleão de Noronha", *Bol. Ger. De Med. e Farmácia* (Nova Goa).
"Febres Remitentes da India (estudos combinados de Clínica e Instituto Bactereológico)-Um caso de febre climática. Obs. Clínica deJoão Barreto (hemocultura na 3ª semana negativa; R. Widal negativa)" , *Bol. Ger. De Med. e Farmácia (*Nova Goa).
"La pneumonie oesteuse de Childe", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
*Relatorio da Campanha Anti-pestosa em Vasco da Gama (*Nova Goa: Imprensa Nacional).

1912 "Febres remitentes na India", *Bol. Geral de Med. e Farmácia (*Nova Goa).
"Albumino-réaction dês crachats et critique sur sa valeur clinique", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Chólera, cholérine, diarrhées", *Bol. Ger. de Med e Farmácia (*Nova Goa).
"Estado actual da Ciência sobre a tuberculose pulmonar", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Quelques considérations sur l´éxistence de

l´Ankylostomiase à Goa et des mesures à prendre pour la combattre", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Chronica - Associação Médico-Cirúrgica da India Portuguesa", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Interesses Profissionais", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Chronica - O Nosso Fim - Prospecto", *Bol. Ger. de Med. e Farmácia* (Nova Goa).

1913 *Traitement de la lèpre* (Paris: Presse Medicale).
"Une nouvelle conception sur le mode d´action des tuberculines", *Bol. Ger. de Med. e Farmácia (*Nova Goa).

1914 "Alguns problemas sobre a malária em Goa", *Iª Conferência Sanitária de Goa* (Nova Goa).
"Ankilostomiase em Goa", *Iª Conferência Sanitária de Goa* (Nova Goa).
"Contribuição ao estudo das febres remitentes ou climáticas", Iª *Conferência Sanitária de Goa* (Nova Goa).
"Contribution to the study of Malaria in Goa", *All India Sanitary Conference (*Lucknow).
"What are the diseases whose notification should be rendered compulsory in Portuguese Índia", *All India Sanitary Conference (*Lucknow).
"Notas sobre a Bilharziose e outras infestações verminosas nas tropas expedicionárias africanas", *Bol. Ger. de Med. e Farmácia (*Nova Goa).
"Profilaxia malárica nas povoações rurais das Novas Conquistas", *Iª Conferência Sanitária de Goa (*Nova Goa).
"Un programme à suivre dans la délaration obligatoire de la tuberculose à l´Inde Portugaisse", *Rev. D´Hyg. et Police Sanitaire (*Paris).
Relatório apresentado ao Governo da Índia Portuguesa. Conferência Sanitária de Lucknow (Nova Goa: Imprensa Nacional).
Variola e vaccina na India Portuguêsa, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de

Nova Goa (Nova Goa: Imprensa Nacional).
Alguns problemas relativos à Malária em Gôa, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de Nova Goa (Nova Goa: Imprensa Nacional).
Anafilaxia local na vacinação e viabilidade do seu emprego, como reacção de imunidade, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de Nova Goa (Nova Goa: Imprensa Nacional).
Ankilostomiase em Goa, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de Nova Goa (Nova Goa: Imprensa Nacional).
As colerinas ou diarréas coleriformes contagiosas de Goa são provocadas pelo vibrião de Koch, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de Nova Goa (Nova Goa: Imprensa Nacional).
Contribuição para o estudo das febres remitentes ou climáticas da Índia Portuguesa, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de Nova Goa (Nova Goa: Imprensa Nacional).
Profilaxia malarica nas povoações rurais das Novas Conquistas, Memória apresentada à conferência sanitária da Índia Portuguesa. Serviço de Saúde da Índia Portuguesa, 1.ª Conferência Sanitária, Em Comemoração do 72.º aniversário da Escola Médico-cirúrgica de Nova Goa (Nova Goa: Imprensa Nacional).

1915 "A campanha anti-leprosa na India Portuguesa",

Arquiv. Esc. Med.-Cirurg. De Nova Goa (Série B).
... and Rómulo de Noronha, "Contribuição ao estudo dos peixes larvicidas de Goa", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Preliminary note on a new Haemogregarine found in the pigeons´blood", *Ind Journ. of Med. Res.*

1916 ..., Atmara Borcar and Loreto De Sousa, "Contribution à l´étude des fièvres remittentes de l´Inde Portugaise", *Anais Scientíficos da Faculdade de Medicina do Porto,* III (1916); published without maps also in, *Bol. Geral de Med. e Farmácia* (Nova Goa, 1917).
..., Belmiro Fernandes and Loreto de Sousa, "Os primeiros bacilos disentéricos isolados em Goa", *Bol. Geral de Med. e Farmácia* (Nova Goa).
"Novos métodos de tratamento da ankilostomiase", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"O Tricophyton rosaceum Sab. deve existir no Norte de Porugal", *A. Med. Moderna (*Oporto).
"A contribution to the study of haemoprotozoa in Portuguese India", *Indian Journal of Medical Research*, III (4) (Sep.).
"Quelques considérations sur les affinités zoologiques du genre 'Hoemocystidium', avec description d'une espèce nouvelle", *Anais Scientíficos da Faculdade de Medicina do Porto*,.III (1) (Sep.).

1917 ... and C. F. de Menezes, "Um caso de Sodoku em Goa", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Blastomyces and Blastomycosis-paper presented to the Indian Science Congress, Lahore", *Ann. Sci. Fac. de Med. do Porto.*
"Quelques considerations sur les affinités zoologiques du genre Haemocystidium avec description d´une espéce nouvelle", *An. Soc. Fac. de Med. do Porto.*
"In the seven days´fever of Leonard Rogers existing in Goa?", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Notas clínicas sobre um caso d´amebiase entero-hepática", *Bol. Ger. de Med. e Farmácia* (Nova

Goa).
"O sindroma febril nas amebiases hepáticas atenuadas", *Bol. Geral de Med. e Farmácia* (Nova Goa).
"The Tricophyton viannai sp. n. agent of a case of Dermatomycosis", *Ind. Journ. of Med. Res.*
"Um caso de antracose pulmonary simulando a tuberculose", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Um caso de oclusão intestinal provocado pela ascaridiose", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Instituto de Análises e Vacina - Mapa das vacinações e revacinações efectuadas nesta Província desde Julho de 1915 a Junho de 1916", *Boletim Sanitário, Estado da Índia* II (1).
"Hématozoaires et pseudo-hématozoaires de l'Inde Portugaise", *An. Sc. da Fac. de Med. do Porto*, III(3) (sep).

1918 "Endomyces cruzi, n. sp. (agent?) d´une endomycose bronchique simulant l´asthme", *Arquiv. Hig. E Path Exot*., VI (Lisbon).
... and António Parras, "Estudos experimentais sobre o valor insecticida dos diversos processos empregados em Goa nas campanhas anti-pestosas", *Arq. Hig. e Path. Exot.,* Vol. VI, Lisbon.
... and Armando Ferreira Álvares, "Um caso de blastomicose com abcessos múltiplos", *A Med. Moderna* (Oporto).
... and Santana Pais, "Un cas de Saccharomycose avec abcès multiples simulant la scrofulose", *Arquiv. Hig. E Path Exot*.,VI (Lisbon).
... and Luis Gonzaga Fernandes, "Sur la fréquence du parisitisme dês voies respiartoires humaines par dês champignons du type des levures", *Arquiv. Hig. E Path Exot*., VI (Lisbon).
..., Ramacrisna P. Loundó and Frederico L. Rebelo, "Études sur le beribéri humain et aviaire", *An. Sci. Fac. Med. Porto*, IV (1).
"Notes cliniques sur un cas d'amébiase urinaire", *A Medicina Moderna* (Oporto).
"Some general remarks on medical mycology and mycological technique", *Trans. Second Mycol. Conf.,* Pusa, 1918; also in *Bol. Ger. de Med e*

*Farmácia (*Nova Goa, 1919).
"Um essai de classification dês champignons appartenant à la classe des Blastomyces", *Arquiv. Hig. E Path Exot*., VI (Lisbon).
"Un cas de Nocardiose pulmonaire simulant la phtisie", *Arquiv. Hig. E Path Exot*., VI (Lisbon).
"Estudos experimentais sobre o valor insecticida e bactericida dos processos empregados em Goa nas desinfecções antipestosas", *Arquiv. Hig. E Path Exot.,* VI (Lisbon).

1919 "Contribution à l´étude de la faune parasitaire d´Hodotermes viarum Koenig de Coimbatore", *Na.da Acad. Politecn. do Porto.*
... and J. Jacques, "Note sur l´existence de l´Herpotomonas muscae domesticae à l´Inde Portugaise", *Bol. de Med. e Farmácia (*Nova Goa).
... and L. J. Brás de Sá, "Contribution to the study of Haemoprotozoa in Portuguese Índia", *Ind. Journ. of Med. Res.*
and Diogo Miranda, "Sobre quistoa hepáticos de natureza cestódica encontrados em murinos de Goa", *Bol. Ger. de Med. e Farmácia (*Nova Goa).
C. S. Sunctancar, "Infection buccale par les ..., ayant son point de depart dans l´éclosion de la dent de .....", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
Roberto Mesquita, "Spirochaeta Eurygyrata Werner *emend.* Fantham dans les sellles normalles et cholériques à l´Inde Portugaise", *Bol. Ger. de Med. e Farmácia (*Nova Goa).
"Os parasitas multiciliados da cariá na Índia Portuguesa", *Bol. d´Agricultura* (Nova Goa).
"Um caso de hepatite amebiana jugulado por injecções de emetina", *Bol. Geral de Med. e Farmácia (*Nova Goa).
"Nocardia (Cohnistreptothix) rogersi sp. N. parasite dês voies respiratoires d´un soidisant tuberculeux, in *A Med. Contemp.* (Lisbon).
"Note sur les Trinconymphides de l´Inde et de Ceylan", *Na.da Acad. Politecn. do Porto.*
"Rapport sommaire sur la nature dês soidisant cholérines ou diarrhées cholériformes à l´Inde Portugaise", *Bol. Ger. de Med e Farmácia* (Nova Goa).

"Sindromas coleriformes sine cólera (crónica)", *Bol. Ger. de Med e Farmácia* (Nova Goa).
"The Triconymphid parasites of some Indian Térmites", in *Proceedings of the Third Entomol Meeting*, Pusa.
and J. F. Sto. António Fernandes, "Revision des champignons appartenant au genre Nocardia", *Memoirs of the Asiat. Soc. of Bengal* (Calcutta).
"Un cas de spirochétose pulmonaire à type sanglant de Violle", *Bol. Ger. de Med. e Farmácia* (Nova Goa).

1920 "Aspergillus (Sterigmatocystis) polychromus", *Ind. Journ. of Botany*.
"Considérations sur les Triconymphides de l´intestin de l´Archothermopsis wroughtoni Desn, étudiés par le Dr. A. Imms", *Bull. de la Soc. Portug. des Sci. Nat. (*Lisbon).
... and A. do Rosário Costa, "Notes sur un vibrio spirochète coprophytique, parasite de l´intestin humaine", *A Med. Moderna* (Oporto).

1921 "Epidermophyton salmoneum n. sp., agent d´une épidermophytie inguinale à l´Inde Portugaise", *Compt. Rend. de la Soc. De Biol.* (Paris).
"Essai d´identification dês Triconimphides sommairement décrites par le Prof. Bugnion chez les térmites de Ceylan", *Arq. Indo-Port. Med. e Hist. Nat.* (Nova Goa).
... and L. J. Brás de Sá, "Contribution à l´étude de la faune anophéline de l´Inde Portugaise (texte aussi en portugais)", *Arq. Indo-Port. de Med. His. Nat*. (Nova Goa).
... and Francisco Paula de Sousa Noronha, "Uma família atacada de eritrodermia congénita ictiosiforme hiperedermotrófica de Brocq", *Arq. Dermo-sifiligráfico* (Madrid).
... and J. A. do Carmo Vaz, "Contribution à l´étude des Aspergillés indiennes", *Arq. Indo-Port. de Med. e Hist. Nat*. (Nova Goa).
... J. M. R. da Piedade e Sousa and J. Mariano Alavares, "Como procuramos resolver o problema da possibilidade da endemização da nossa Índia da bilhrziose importada pelas tropas africanas (article de Carlos França e Froilano de Mello

intitule Bilhrziose na Índia e em Portugal. Le travail supra fut presente au Congrés Luso Espagnol reuni à Porto en 1921)", *A Med. Contemp*. (Lisbon).
"Protozoaires parasites de Pachelabra moesta Reeve", *Compt. Rend. Soc. Biol.* (Paris).
"Novas pesquisas sobre os parasitas do Leucotermes indicola (texte aussi en français)", *Arquiv. Indo-Port. de Med. e Hist. Nat.* (Nova Goa).
"Note sue trios espéces de levures du jus de cajou, fruit d´Anacardium occidentale", *Compt. Rend. de la Soc. De Biol.* (Paris).
"Nouvelles recherches sur les parasites intestinaux du Leucotermes indicola, (comprenant une revision spéciale de la planche 51 du travail original de Leidy)", *Arq. Indo-Port. Med. e Hist. Nat.* (Nova Goa).
"Recherches sur quelques Triconymphides du Leucotermes indicola (comprenant une revision spéciale de la planche 51 du travail original de Leidy)" *Arq. Indo-Port. Med. e Hist. Nat.* (Nova Goa).
"Une épidemie de meningite cérebro-spinale dans l´Inde Portugaise", *Bull. Soc. Path. Exotique* (Paris).
... and Pedro Correa Afonso, "First Entomological Records in Portuguese Índia",in *Proceed of the IV Entomological Meeting*, Pusa (Bihar & Orissa).
... and Fideles Fernandes, "Première contribution à l´étude des levures du *sura* du cocotier", *Arq. Indo-Port. de Med. e Hist. Nat.* (Nova Goa).
"Sur quelques levures du soura do cocotier", *Compt. Rend. de la Soc. De Biol.* (Paris).
"Malária na Índia Portuguesa", *Arquivos Indo-Portugueses de Medicina e História Natural.*

1922 "Febres remitentes climáticas na India Portuguesa", *Med. Contemporânea* (N.B.-transcrit. In *Bol. Ger. De Med. e Farmácia*, 1924).
... and Loreto de Sousa, "Resultados de 22 meses de tratamento pelo Ginocardato de Soda A", *Portugal Médico* (Oporto).
... and Crisna Suctancar, "Morphologie et cycle évolutif d´un Herpetomonas de l´intestin

d´Haemidactylus brookei Gray", *Bull. Soc. Path. Exot. (*Paris).

"Sur la citologie d´un Eutrichomastix de l´intestin de Calotes versicolor Daudin, subspecies major Blith", *Compt. Rend. Soc. Biol*. (Paris).

1923 ... and Lakshama Ladda, "Spirochètes dês cavités buccales humaines à l´Inde Portugaise et leurs relations avec la pyorrhée alvéolaire", *A Med. Moderna*, (Oporto).
"Note sur une Trichonomade parsite de deux espéces de Térmites de Benguella, avec références spéciales à la complexité de son appareil basal", *Comp. Rend. Soc. du Primeiro Congr. de Med. Trop*., Luanda.
"On the neuromotor system of the active forms of na Eutrichomastix parasite from the intestine of a common Indian lizard", *Ind. Journal of Med. Res.*
"Investigação bacteriológicas", *A Índia Portuguesa,* (2) (Nova Goa: Imprensa Nacional)
"Investigação protozoológicas", *A Índia Portuguesa,* (2) (Nova Goa: Imprensa Nacional)
"Onze anos de investigações laboratoriais", *A Índia Portuguesa* (2) (Nova Goa: Imprensa Nacional).

1924 "A endemia tifoide na Índia Portuguesa (acta da Conferência sobre a Febre tifóide-Conferência conjunta das autoridades sanitárias e membros da Associação Médico-Farmacêutica)", *Bol. Ger. De Med. e Farmácia* (Nova Goa).
"Caractères du Spirochaeta bronchialis Cast.", *Bull. Soc. Path. Exot*. (Paris).
"Deux nouveaux cas de Spirochétose broncho-pulmonaire", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Essais expérimentaux de traitement de la Spirochétose Eurygyrata par quelques spirillicides modernes", *Bull. Soc. Path. Exot.* (Paris).
... and Luiz J. Braz de Sa, "Origem das febres tifóides em Goa", *Bol. Ger. De Med. e Farmácia* (Nova Goa).
Bruno Pereira Mesquita,"Spirochétoses

intestinales humaines à l´Inde Portugaise", *Bull. Soc. Path. Exot.* (Paris).
..., Luiz J. Braz de Sa and Gonopoti X. Colopo, "As febres remitentes de Goa são contagiosas e provocam epidemias", *Bol. Ger. De Med. e Farmácia* (Nova Goa).
"Identificação morfológica do Sp. Bronchialis Cast. e sua diferenciação dos espiroquetas das arcadas alvéolo-dentárias", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Observações das febres remitentes de Goa e sua identificação pelo diagnóstico bacteriológico", *Bol. Ger. De Med. e Farmácia (*Nova Goa).
"Spirochétose broncho-pulmonaire", in *pratique des maladies des pays* .....(p. 54) (Paris).

1925 "Breves considerações sobre o estado actual da Quimioterapia anti-leprosa (com impressões clínicas pessoais sobre algumas das medicações preconizadas)-com. ao Cong. Luso-Espanhol reunido em Coimbra", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Estado actual da Quimioterapia antileprosa", *A Medicina Ibera* (Madrid).
"État actuel de la chimiothérapie antilépreuse", *Presse Medicale* (Paris).
... and V. Camotim, "Premier cas autochtone de Bouton d´Orient à Goa", *Arq. Indo Port. de Med. e Hist. Nat.* (Nova Goa).
"Some remarks upon Spirochaeta bronchialis Castelani and ronchial spirochaetosis", *Journ. of Trop. Med. & Hyg.* (London).
"Pneumonie grippale ou Spirochétose broncho-pulmonaire aigue compliquée pendant la convalescence d´une septicémie ayant son point de départ dans les poumons affaiblis?", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Spirochétose bronco-pulmonaire", *Arq. Indo-Port. De Med. e Hist. Nat.* (Nova Goa).
... and Joaquim Cabral, "Um caso de prurigo de Hebra tipo Hebra Kaposi", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Sur les flagellés parasites de l´intestin de Naja tripudians", *Arquiv. Indo-Port. de Med e Hist. Natural* (Nova Goa).

"Malaria no Concelho de Sanquelim", *Arquivos Indo-Portugueses de Medicina e História Natural*, II (Nova Goa).

1926 "Considerações sobre alguns casos de desinteria amebiana e da emetinoresistência das amebas", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Note sur la fréquence des parasitoses intestinales à l´Inde Portugaise", *Bull. Soc. Path. Exot.* (Paris).
... and j. M. Alvares, "Carcarias parasitas do Indo-planorbis exustus", *Arq. Indo-Port. de Med. e Hist. Nat.* (Nova Goa).
... and Francisco Barreto, "Contribution à l´étude de la valeur diagnostique de la Réaction de Gate et papacostas et quelques réactions alliées", *Bol. Soc. Path. Exot.* (Paris).
"Sur la duré de surveillance des chiens mordeurs pour despiste lar age canine", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Note complementaire sur quelques faits concernant de phénoméne de formol-gélification", *Bol. Soc. Path. Exot.* (Paris).

1927 ... and H. P. Vernencar, "Effets du traitement par la Smalarina Cremonese sur 6 malades attéints de malária chronique avec recidives fébriles", *Bull. Soc. Path. Exot.* (Paris).
... and J. Cabral, "Action de léparseno en deux cas de lèpre mixte", *Bull. Soc. Path. Exot.*, (Paris).
"A Escola Médica de Goa e a sua contribuição à cultura das Ciências Médicas (discurso presidencial)", *Arq. Esc. Med. Cirurg. de Nova Goa* (Série B).
"Doenças da tropa e maneira de as combater", *Arq. Esc. Med. de Nova Goa* (Série B).
"Relatório sobre a meningite da Provincia de Salcete referido ao periodo de dois meses, decorridos entre 9 de Março a 10 de Maio de 1927", *Arq. Escola Med. Cirurg. Nova Goa* (Série B).
"Note sur la fréquance des parasitoses à l´Inde Portugaise", *Arq. Esc. Méd. Cirur. de Nova Goa* (Série A).
"Nouvelles études sur les résultats de la Smalarina Cremonese", *Bull. Soc. Path. Exot.*(Paris).

"Revision des Triconymphides du Leucotermes indicola Wasm", *Arquiv. Esc. Med. Cirurgica de Goa* (Série A).
"Primeira Conferência da Lepra na Índia Portuguesa", *Arquiv. Indo-Portugueses de Med. e História Natural*, IV.
*História da Lepra na Índia Portuguesa (*Nova Goa).
"Sugestões para a profilaxia da lepra em Goa", A*rquivo Indo-Português de Medicina e Historia Natural*, IV (Nova Goa).
*A mulher Hindu (*Bastorá: Tipografia Rangel)

1928 "Apects cliniques et épidémologiques de la meningite cérebro-spinale dans l´Inde Portugaise", in *Trans. VII Congress Far. Eastern Association of Trop. Med.,* Calcutta, 1928; also in *Arq. Escola Med. Cir. de Nova Goa* 1929 *(* Série A, Fasc. 4).
"Contribuição ao estudo do valor terapêutico da Smalarina Cremonese", *Arquiv. Escola Med. Cir. de Nova Goa* (Série A).
"Études expérimentales sur la valeur prophylactique-(mémoire présenté à l´Indian Science réuni à Allahabad)", *Arquivos da Escola Médico-Cirúrgica de Nova Goa* (série A).
... and Francisco Pacheco de Figueiredo, "Primeiras experiências do tratamento Yatrénico em 2 anos de amebiase intestinal", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
... and Joaquim Cabral, "Um caso de purigo de Hebra", *Bol. Ger. de Med. e Farmácia (*Nova Goa).
... and L. J. Bras de Sa, "Malária na Índia Portuguesa (Damão, Diu e Praganã)", *Arquiv. Indo-Port. de Medicina e Hist. Nat*. (Nova Goa).
... and J. L. da Cruz, "Résultat du traitement experimental de divers états d´amébiase intestinale par le Yatren purissimum", *Bull. Soc. Path. Exot.* (Paris).
..., Maria Francisca Fernandes, Francisco Correia and Macario Lobo, "Études sur le sang de *Manes pentadactyla* L.", *Arquiv. Esc. Med. Cirurg. de Nova Goa (*Série A).
"Impressões clínicas sobre o tratamento da desinteria amebiana pelo Yatren purissimum",

Bol. Ger. de Med. e Farmácia (Nova Goa).
"L´incursion du choléra à l´Inde Portugaise en 1927", *Arq. Escola Med. Cirur. De Nova Goa* (Série B, Fase 3ª).
"Rapport sur les résultats du traitement dês divers états du paludisme pa la Samalarina du Prof. Cremonese", in *Transactions of the VII Congress of the Far. East. Assoc. of Trop. Med*., Calcutta, 1928 (Also in *Arquiv. Escola Med.-Cir. de Nova Goa*, Série A, 1929).
"Recherches sur la valeur de la vacination orale antitypique", *Arquivos da Escola Médico-Cirúrgica de Nova Goa* (série A).
"Revision des Triconymphides du Leucotermes indicola Wasm (continuation)", *Arquiv. Esc. Med. Cirurgica de Goa* (Série A).
"Sur le commensalisme de la faune spirochétique des arcades dentaires et de l´intestin de quelques mammifères domestiques", in *Trans. of the VII Congr. Of Far East Assoc. of Trop. Med. (*Calcutta).
"Syndrome anaphylactique après l´injection d´un gramme de chlorydrate de quinine", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Triconymphides de l´intestin du *Leucotermes indicola*, Wasm, avec référence spéciale à la complexité de leurs phénomènes mitotiques", in *Trans. of the 7th Cong. Far. East. Assoc. of Trop. Med.*, (Calcutta).
"Un croisade internationale, combatant la Lèpre, simultanément dans tout les pays, pourrait éteinre ce fléau en quelques decades", in *Trans. Congrés de Med. Tropicale du Caire.*
"Wie soll die Lepra bekampampft werdem", *Die Medizin Welt* (Berlin).
... and António Fialho, "Sur les spirochètes commensaux dês árcades dentaires et de l´intestin de l´homme et de quelques animaux domestiques", *Giornale di Batt. e Imunologia* (Torino).

1929 ... and Arnaldo Rodrigues, "Preliminary note on a cãs of Dermatomycosis with multiple verrucose or ulcerated patches", *The Antiseptic* (Madras).
... and Eméico Noronha, "L´épreuve des

aglutinines dans la vaccination par les bilivaccines antitypiques", in *Compte Rendu de la Soc. de Biol. de Paris (Sec. Portugaise).*
... and Julio Brito, "Sur trois espèces de Devescovina parasites de l´intestin d´un Térmite recolté à Damaun (Inde Portugase) et de la complexité de leur appareil kinétoplastique", *Arqiv. Escol. Med. Cirur. de Nova Goa* (Série A); "Sur un Calonymphide parasite d´un Térmite indien", *Compt. Rend. Soc. Biol.* (Paris).
"History of Medicine in Portuguese Índia", *National Med. College Magazine (*Bombay); also in *Arq. Esc. Med. Cir. de* Nova Goa (Série B).
"Indicações do emprego da plasmoquina na terapêutica e profilaxia da malária", *Bol. Ger. de Med. e Farmácia (*Nova Goa).
"Metastephanonympha perronciti n. gen. N. sp., calonymphide parasite de l´intestin d´un térmite de Damão", *Arq. Escola Med. Cirurg. de Nova Goa* (Série A).
"Résultat du traitement experimental de divers états d´amébiase intestinale par le Yatren purissimum (mémoire complete)", in *Congrès de Médicine Tropical du Caire;* also in *Arq. Esc. Med. Cirur. de Nova Goa (*Série A).
"Sur l´emploi de la plasmoquine dans le traitement du paludisme", *Presse Medicale* (Paris).
"Sur un cas de Blastomycose à placards multiples végétants verruqueux ou pustule-ulcéres", *Bull. Soc. Path. Exot*. (Paris).
"Sur une méthode pour délimiter l´éntendue des aplénomegalies et enrégistrer d´une façon precise leurs oscillations ultérieurs", *Bull. Soc. Path. Exot. (*Paris).

1930 Breves considerações sobre a micologia médica (conferência feita na Sociedade Médica de Salcete em Abril de 1929), *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Considérations à propôs de la cystite amébienne", *in Compt. Rend. de la V Reunion Argentina de la Patologia*, Jujuy, 1930; also in *Arq. Escola Med. Cirurg. de Nova Goa* (Série A).
... and Crisna Sansguiri, "Réactions locales

anaphylactiques vis-á-vis de l´immunisation typique", in *Compte Rendu de la Soc. de Biol. de Paris (Sec. Portugaise).*

..., L. J. Bras de Sa and Mariano d'Abreu, "Contribution à l´étude du traitement du paludisme par la plasmoquine", *Giornale di Batteriologia e Imunologia*, 1930 (Jan.), (Torino); also in *Arquiv. Escola Med. Cirurg. de Nova Goa (*Série A).

"L´épreuve de flocculation vis-à-vis de l´immunité antityphique", in *Compte Rendu de la Soc. de Biol. de Paris (Sec. Portugaise).*

"O Fomento das Novas Conquistas e suas relações com os problemas de assistência e saneamento", in *Terceiro Congresso Colonial Nacional*, Lisboa; also in *Bol. Ger. Med. e Farmácia (*Nova Goa, 1931).

"Some remarks on medical mycology and the large field it offers for research work in Índia (lecture delivered in the Seth Gordandas Sunderdas Medical College of Bombay)", *Arq. Esc. Med. Cir. de Nova Goa* (série B); also in The *Antiseptic, 1929 (Mars) (*Madras).

"Infusoires parasites du Racophorus maculates Grey", in *Compt. Rend, XI Congrès Internat. de Zool.,* Padova 1930; also in *Arquiv. Ecole Med. Cirurg. de Nova Goa (*Serie A), 1930. Also in *Comp. Rend. Soc. Biol.,* 1930 (Paris).

*Le Service de Santé à l'Inde Portugaise (*Nova Goa: Imprensa Nacional).

1931 "A orientação da campanha antimalárica nas Novas Conquistas, seus resultados práticos e a lição que deles deriva para a nossa conduta futura", *Bol. Ger. de Med. e Farmácia* (Nova Goa); also in *A Med. Contemp*., August 1937 (Lisboa).

... and Roguviras S. Poi Vernencar, "Sur la valeur dês diverses méthodes de mensurations spléniques pour le dressage dês cartes malariennes", in *Compt. Rend. II Congrès International du Paludisme*, Alger.

"Sur un cas d´anémie grave (pernicieuse plastique). Résultats brillants du traitement par la ventriculine", *Bull. Soc. Path. Exot. (*Paris); Also in *Bol. Ger. de Med. e Farmácia* (Nova Goa).

"Le problème de la leper dans l´Inde Portugaise",

Rev. d´Hygiène et de Med. Preventive V (Paris).
"Nature et identification dês petits flagellés de l´intestin de Coptotermes heimi Wasm", *Comp. Rend. Soc. Biol.* (Paris).
"Sur un petit flagellé à caracteres fixes intermédiaires entre les genres Trimitus, Eutrichomastix et Devescovina", in *Comp. Rend. de la VI Reunion Argentina de la Soc. De Patologia*, Jujuy.
"Contribution à l´étude des Hémogrégarinides dês tortues indiennes. *I Haemogregarina malabarica* n. sp. Et son cycle évolutif chez *Emyda granosa* subspecies *vittata* Peters (mémoire présenté à l´Indien Science Congress réuni à Nagpur en 1931)", *Arq. Esc. Med. Cirurg. De Nova Goa*, (série A), 1932; summary in *Proc. of Ind. Science Congress*., Nagpur, 1931).

1932 "Contribution à l´étude de l´action plasmodicide de l´Atébrine", *Revista di Malriologia*, Roma; also in *Bol. Ger. de Med. e Farmácia* (Nova Goa, 1933).
"Contribution à l´étude dês Hémogrégarinides des tortues indiennes. *II* Sur une Hemogrégarine parasite de Emyda granosa Schoepf.", *Arq. Esc. Med. Cirur. de Nova Goa.*
"Contribution à l´étude dês infusoires parasites de anoures du Malabar", *Record of the Indian Museum*, XXXVI (Calcutta).
... and António d'Azevedo, "Preliminary note on the Plasmodicide Action of Atebrine", *Patna Journal of Medicine*, VII (nº 4).
..., L. J. Bras de Sa and António d'Azevedo, "Résumé dês observations concernant l´action plasmodicide de l´Atébrine", *Bull. Soc. Path. Exot.* (Paris).
"Note preliminaire sur l´action plasmodicide de l´Atébrine", *Bull. Soc. Path. Exot.* (Paris).
"Sur une nouvelle espèce de Scopulariopsis (S. sehnsucta) trouvée à l´Inde Portugaise", *Arq. Esc. Med. Cirurg. de Nova Goa.*
"Sur une nouvelle espèce de Scopulariopsis trouvée aux Indes Portugaises", *Bull. Soc. Path. Exot. (*Paris).
"On the nature and identification of some small Trichomonada from the intestine of Térmites

hitherto related to the so called Trimitus stages of Duboscq and Grassé (paper presented to the Indian Science Congress-Bangalore)", *Arq. Escola Médico-Cirúrgica de Nova Goa* (Série A).
"Un court apercu historique sur l´évolution de la medicine à l´Inde Portugaise", in *Compte Rend. Neuvième Congrès International d´Histoire de Médicine*, Bukarest.

1933 "A scheme for malarial sanitation in rural areas", *The Antiseptic* (Madras).
... Alexandra Emmanelow and Humberto d'Albuquerque, "Contribuição para o estudo do hemograma de Schilling em Goa", *Bol. Ger. de Med. e Farmácia* (Nova Goa).

1934 "Conferência Provincial sobre a tuberculose", *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Some suggestions on the measures to be taken to avoid the spreading of meningitis in India", *The Patna Journal of Med.*
"Leucocyto-reactions and their value for the diagnosis of Syphilis", *Proc. Ind. Acad. of Sciences*, Section B (Bangalore).
"Nota final sobre a presente campanha anti-palustre", *Arq. Esc. Med.-Cir. de Nova Goa*, (Série B).
"Premiére Campagne antimalarienne active à Goa", *Arq. Esc. Med.-Cir. de Nova Goa*, (Série B).
"Contribution à l´étude du Cycle évolutif dês Haemocystidium", *Arq. Esc. Med. Cirur. de Nova Goa* (Série A).
... and Jack Siqueira, "Sobre a etiologia dos sindromas entirídicos e desinteriformes que sob forma epidémica grassaram em Goa em fins de 1933", *Bol. Geral de Med. e Farmácia* (Nova Goa).
..., J. S. de Carvalho and Pundolica Gaitondo, "Cytological studies on Nyctotherus ovalis with special references to its morphological types", Proc. *Ind. Acad. of Sciences*, Section B, Oct. (Bangalore).
"Sur la génèse des alterations rencontrées dans le sang d´individus apparentement normaux de l´Inde Portugaise", *A Medicina* (*revista de Ciências Médicas e Humanismo*), Nov. (Lisboa).
"Serviços de Saúde na Índia Portuguesa -

informação e estatísticas sanitárias referentes ao ano de 1932", *Boletim Geral das Colónias* X (107) (Lisboa).

1935 "A contribution to the study of the blood parasites of some Indian birds", *Proc. Ind. Acad. of Sciences,* Section B (Bangalore).
"A short report on the blood parasites of some Indian birds", in *Compt. Rendus du XII Cong. Intern. De Zoologie*, Lisbon.
... and Emidio Afonso, "On the blood parasites of *Coracias b. benghalensis* with reference to its two types of Leucocytozoon", in *Proc. Ind. Acad. of Sciences*, Section B (Bangalore).
... and Macario Raimundo, "Morphology and schizogonic cycle of *Haemoproteus raymundi* n. sp. parasite of *Leptocoma zeylanica* Lin.", *Proc. Ind. Acad. of Sciences* , Section B (Bangalore).
... and O. Loyola Pereira, "Les injections intraveineuses d´huile de Chaulmogra", *Bull Soc. Path. Exotique (n. 8)* (Paris).
"On haemoprotozoa of Indian birds", in *Compt. Rend. XII Congr. Inter. Zoologie,* Lisbon.
"Levures et levuroses (en collaboration)", *Arq. Esc. Med. Cirurg. de Nova Goa.*
"New trypanosomids of some Indian birds", *Proc. Ind. Acad. of Sciences,* Section B(Bangalore).
"On a toxoplsmid of Fulica atra L. with special reference to a probable sexuality of agametes", *Proc. Ind. Acad. of Sciences,* Section B (Bangalore).
"On blood microfilaria of Indian birds", *Compt. Rend. XII Cong. Internat. Zool.,* Lisbon.
"On Giardia herodiadis sp. N., parasite of the intestine of Herodias intermedias Wagler, with special reference to its neuromotor apparatus", in *Compt. Rendus du XII Cong. Intern. De Zoologie,* Lisbon.
"Chimioprofilaxia das localidades maláricas e seus resultados práticos após dois anos de experiência pessoal", in *Jornadas Médicas Galaico-Portuguezas,* Orense; also in *Portugal Médico*, 1936 (May) (Porto).
"On two spiral organisms living in the intestinal tracto of *Gallinula chloropus* L.", *Proc. Ind. Acad.*

of Sciences, Section B, (Bangalore).
"Relatório sobre 109 doentes internados na Leprosaria desde 17-V-32 a 31-XII-34", *Arq. Escola Med. Cirurg. de Nova Goa (*Série B).
"Sur les mollusques indiens pouvant server d´hôtes éventuels dans la transmission de la bilharziose urinaire", in *Compt. Rend. XII Cong. Internat. Zool.,* Lisbon.
"Traitement et guérison de la lèpre", in *II Semaine Med. Internationale,* Montreux.
"Treatment of Leprosy by intravenous injections of pure Chaulmogra oil", *Medical Digest (*August*) (*Bombay).
"Morphologie et cycle évolutif d´une nouvelle esp>ècе d´Haemoproteus, parasite de Leptocoma zeylanica Lin.", *Arq. Esc. Med. Cirurg. de Nova Goa* (Série A).
"New haemoproteids of some Indian birds", *Proc. Ind. Acad. of Sciences,* Section B (Bengalore*).*
"New Tripanosomidsof some Indian birds", *Proc. of the Ind. Acad. of Sciences,* Section B, (Bangalore).
"Traitment de la lèpre d´apres 3 ans d´expérience personelle", *XI Congrès International de Dermatologia de Budhapest.*

1936 "An explanation to the occurrence of sporadic cases of schistosomiasis in India," *Proc. Ind. Acad. of Sciences*, Section B (Bangalore).
"Como eu trato os meus leprosos (conclusões baseadas em três anos de experiências na Leprosaria Central de Macasana)", in *Jornadas Médicas Galaico Portuguesas*, Orense 1935; also in *Portugal Médico*, 1936 (Porto).
... and Ciriaca Vales "On a trypanosome found in the blood of the Indian fresh water fish Clarias batrachus Lin.", *Proceed. of the Indian Acad. of Sciences*, Section B (Bangalore).
... and Amerciano Dias, "Plasmodium narayani n. sp. Parasite of the fish other Lutra lutra", *Proc. Ind. Acad. of Science,* Section B, (Bangalore).
... and Ciriaca Vales, "Haemogregarina thirsoideae n. sp. parasite of the Indian Eel Thirsoidea macrurus Bleaker", *Proc. Ind. Acad. of Sciences*, Section B (Bangalore).

"Further contribution to the study of the Blood parasites of Indian birds together with a list of the haemoparasites hitherto recorded", *Journ. of the Royal Asiat. Soc. of Bengal*, II (Calcutta).
"O problema da endemia malárica na Índia Portuguesa", *Clínica, Higiena e Hidrologia* (Lisbon)

1937 "A fauna haemoparasitológica dos pássaros indianos", A *Med. Contemp*. (Lisbon).
"Considerações gerais sobre a micologia médica e técnica micológica", *Clínica, Higiene e Hidrologia* (Lisbon)
..., Venctexa Dessai and Vamona Xeldencar, "On a Cercomonad parasite of the intestinal tracto of the penattomid bug Aspongopus obscurus Fabr.", *Proceed. of the Indian Acad. of Sciences*, Section B (Bangalore).
... and Caetano Correa de Meyrelles, "On the nature and identification of some roundish bodies found either free or as endoglobular parasites in the blood of Calotes versicolor Daud, subespécies major Blyth", *Proc. Ind. Acad. of Sciences*, Section B (Bangalore).
... and Luis da Fonseca, "Further notes in the Haemoparasitology of the Indian Birds", *Proc. Ind Acad. of Sc*., Section B, (Bangalore).
... and Caetano Correa de Meyrelles, "On the classification and achizognic cycle of a blood parasite of the Indian lizard Calotes versicolor Daud, subspecies major Blyth", *Proc. Indian Acad. of Sciences*, Section B (Bangalore).
... and Jorge mascarenhas, "Um caso de intertrigo devido a uma levurose cutânea causada por um Geotrichum", *Clínica, Higiene e Hidrologia* (Lisbon).
"Leprosaria Central de Goa (Relatório)", *Arq. Escola Med. Cirurg. de Nova Goa* (Série B).
"Observations résumées du traitment de quelque lépreux par le vaccin de Vaudremer", in *Soc. Path. Exot.* (n. 10) (Paris).
"On the parasitism os Feminine Genital organs by yeasts and yeast like fungi (Feminine genital Levurosis)", *Ind. Journ. Vener. Diseases* (Bombay).

"Sobre a significação das levuroses e seus agentes causais, com especial referência à frequência nos trópicos das levuroses das vias aéreas", *Clínica, Higiene e Hidrologia*, (Lisbon).
"Sobre o parasitismo das vias genitais femininas por fungos levuriformes", *Bol. Ger. de Med. e Farmácia* (Nova Goa); also in *Clínica, Higiena e Hydrologia* (Lisbon).
"Sobre um caso de dermatomicose generalizada úlcero-verrucosa em que os agentes encontrados foram uma microsifonada inidentificada e uma levedura do género Cândida", in *Clínica, Higiena e Hidrologia* (Lisbon).
"Sur le parasitisme des voies génitales féminines par des champignons levuriformes (Levuroses génitales féminines)", *Giorn. de Batt. e Imunologia (*July) (Torino).
"Une vue d´ensemble sur la marche, pendant 15 ans, de la méningite cérébro-spinale à Goa", *Bull. Soc. Path. Exotique*, 10 (1938) (Paris); also in *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"A orientação da campanha antimalárica das Novas Conquistas, seus resultados práticos e a lição que deles deriva para a nossa conduta futura", *Medicina Contemporânea* (34) (Lisbon).
*Les molusques indiens pouvant servir d'hôtes éventuels dans la transmission de la bilharziose urinaire (*Lisbon: Casa Portuguesa).
"La plasmoquination en masse dês lacalités malariennes et ses résultats prophylactiques", *Bull. Soc. Path. Exot.* (June) *(*Paris); s/d "Sur une plasmodie du fourmulier Manes pentadactyla", *Bull. Soc. Path. Exot. (*Paris).

1938 "La campagne antimalarienne dans les régions rurales de l´Inde Portugaise", *Revista di Malariologia* (Rome).
"Chemoprophylaxis of Malária in Portuguese Índia", *South African Med. Journ. (*Dec.); transcription in *O Médico* (Nova Goa, 1939).
"Expériences cliniques sur le traitement des splénomégalies palustres par la méthode d´Ascoli", *A Med. Contemp*. (Nov.) (Lisbon).
"Experimental studies on the treatement of malarial splenomegalies by the method of Ascoli",

South African Med. Journ. (Nov.); also in *Compt. Rendus du Congrès de Iº South Africam Med. Assoc.* Lourenço Marques, 1939.
... and Luís Lobo, "On the morphology and identification of a Trypanosome found in the blood of Haemidactylus brookei Gray", *Proceed. of the Indian Acad. of Sciences*, Section B, (Bangalore).
... and Luiz da Fonseca, "On the achizognic forms of a Plasmodid found in the blood of the green snake Passerita, mycterizans Daud", *Proc. Ind. Acad. of Science,* Section B*(*Bangalore).
... and C. Lobato de Faria, "Sur l´infestation des ulcères leprotiques par des champignons levuriformes", *Micopathologia* (Oct.).
..., Narana Ganencar and Datta Loundó, "On a flagellate of the intestine of Tatera indica Hardwicke", *Proceed. of the Indian Acad. of Sciences*, Section B (Bangalore).
"O problema da Lepra. Como se deve agir e como eu agi na nossa India", Conferência na Liga da Profilaxia Social, Porto. *Vol. das Conferências* 1939; also in *Bol. Ger. de Med. e Farmácia* (Nova Goa).
"Résultat de 5 ans de traitement dans la léproserie de Macasana (Inde Portugaise)", *Press. Med.*,1939 (Paris); also in *Bol. Ger. de Med. e Farmácia,* 1938 (Nova Goa).
"Résultats de 5 ans d´expérience personelle sur la prophylaxie quinosynthétique des régions a haute endémicité palustre", in *Acta Conventus tertii de Tropicis at que malária morbis* (*Congrès d´Amsterdam*).
"On the medico-mycological meaning of the Word levurosis, its causative agents with special reference to the frequency in the Tropics of their incidence in the Respiratory Viae", *The Antiseptic* (July) (Madras).

1939 ... and Luis António Fernandes, "Onychomycose de emdius et annulaire due à une levure du genre Torulopsis Berlese 1894", *Mycopathologia* (July).
... and A. Vaga, "Premier cas de balantidiose humain observe à Goa", *Bull. Soc. Path. Exot.* (Jan.) (Paris).
"L´éntendue des levuroses en pathologie

humaine", *Bruxelles Medical* (Jan.).
"O primeiro caso de Balantidiose humana por Balantidium Coli encontrado em Goa", *A Med. Contemp.* (Jan.) (Lisbon).
"Onicomicosedo médio e anular originada por uma levedura do género Torulopsis Berlese 1894", *A Med. Contemp.*, (Fev.) (Lisbon).
"Os tratamentos antileprosos empregados na Leprosaria de Macasana no curso de 5 anos do seu funcionamento", *África Médica*, (March).
"Two new additions to the list of the Indian Aspergilli", *Proc. Ind. Acad. of Science*, Section B, (Bangalore).
"O primeiro caso de balantidiose humana por *Balantindinn Coli* encontrado em Goa", *A Medicina Contemporânea* (sep.) (Lisbon).

1940 "A report on the characteres and identification of the yeasts living in commensalism in the intestine of some laboratory animals", *Proc. Indian Acad. of Sciences*, Section B, (Bangalore).
"Caractères morphologiques et identification dês levures commensales de l´intestin de quelques animaux de laboartoire", *Arq. Esc. Med. Cirurg. de Nova Goa.*
"Études expérimentales sur l´influence des diètes béribérigènes sur les levures intestinales des animaux", *A Med. Contemp.*, 1940 (May) (Lisbon); also in *Arq. Esc. Med. Cirurg. de Nova Goa.*
"Experimental studies on diets deficient in Vitamina B, and their influence on the intestinal yeast flora of animals", *Proc. Indian Acad. of Sciences*, Section B (Bangalore).
... and Jonas de Sá Viegas, "The phaenomena of dissociation into S. and R. forms observed among the bacteria do also occur in yeast cultures", *Proc. Ind. Acad. of Sciences*, Section B (Bangalore).
"Les cultures des organismes levuriformes montrent aussi des phénoménes de dissociation into S. and R.", *A Med. Contemp.*, 1940 (Lisbon); also in *Arq. Esc. Med. Cirurg. de Nova Goa.*

1941 "Clinical and Epidemiological Features of meningococcemia in Goa", *Antiseptic* (Madras).
... and Belarmino Lobo, "First record on a Amoeba

parasite of an Indian Térmite", *Proc. Ind. Acad. Of Sci.*, Section B (Bangalore).
"Revision of the family Devescovinidae, its genera and species, with record of the Indian species of Devescovina", *Proc. Ind. Acad. Sci.*, Section B, (Bangalore).
Á la veille du centenaire (Bastorá: Tipografia Rangel)

1948/49 "O estado social da mulher hindu à face do folclore indiano", *Estudos Coloniais*. 1 (2/3).

1953 "Contribution à l´étude des triconymphides et d´autres flagellés parasites dês térmites indiens", in *Compt. Rendus du XII Cong. Intern. De Zoologie*, Lisbon.

1955 "A note on mycological and helminthological studies in Portuguese India: 2.º Congresso PIOSA", in *Comunicações portuguesas ao II Congresso da Associação Científica do Oceano Índico*, Perth, Aug 1954 (Lisbon: Associação Científica do Oceano Índico).

1955 "Discurso do Director da Escola, Dr. Froilano de Mello", in *Escola Médico-Cirúrgica. Comemorações Centenárias (1842-1942)* (Bastorá: Tipografia Rangel).

Portugal and the Building of Atlantic Telegraph Networks

– the role of a loser or a winner?

By Ana Paula Silva[*]

Most of the existing studies on submarine cables are built from a national point of view, stressing how great powers, namely Great Britain, France, Germany and the United States struggled to secure their circles of influence.[1] However, the majority of these studies seem to neglect the fact that the 19th century submarine cable technology had a constraint – the need for relay.[2] Therefore, although the worldwide submarine cable network could be mastered by a few powerful states it could only be built by using other

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[1] See Daniel Headrick, *The Invisible Weapon* (New York and Oxford: Oxford University Press, 1991); Pascal Griset, *Les Télécommunications Transatlantiques de la France* (Paris: Éditions Rive Droite, 1996); Peter Hugill, *Global Communications Since 1844* (Baltimore and London: The Johns Hopkins University Press, 1999).

[2] Telegraphic messages were transmitted between two points by an electrical impulse that decreased along the cable. The attenuation effect of electric current compelled to the reinforcement of the electric impulse under water. The message had therefore to be retransmitted along the way towards its destination and the cables had to land for relay purposes. See, Ken Beauchamp, *History of Telegraphy* (London: The Institution of Electrical Engineers, 2001), 160-161.

countries to land the cables. This inherent transnational feature of the submarine cable network created new links between European nations, shaping both their national and international strategies as well as the relationship between the so-called central and peripheral countries.

By bonding countries with very different political and economic status, the building of the worldwide telegraph network exposed tensions and ambiguities as far as the balance of profits and losses for each of the network builders is concerned. Although it is still a question of nations states negotiating a transnational network for their own benefit, a new perspective concerning the overall design of power structures in Europe has to be taken into account. In this "game of winners and losers"[3], of integration and exclusion[4], there is, nevertheless, a gradation of what is perceived as a successful strategy. By focusing on Portugal, a peripheral country in industrialized Europe, the diversity of roles played by less powerful states in the complex process of building tansnational infrastructures can be disclosed.

By 1850, when the British telegraph cable network began to grow, Portugal took advantage of its geographical and geopolitical situation for landing the cables and establishing relay stations both in its European territories (mainland; Madeira and Azores) and in the African colonies (Cape

3 Erik van der Vleuten e Arne Kaijser, "Networking Europe", *History and Technology*, *21* (2005): 21-48, 34.

4 Aharon Kellerman states that the submarine cables network contributed to increase the gap between centres and peripheries through what he called the paradoxical centrifugal/centripetal and decentralising/centralising effect of telecommunication technologies. Aharon Kellerman, *Telecommunications and Geography* (London and New York: Belhaven Press, 1993), 30-33.

Verde Islands, S. Tomé and Principe, Guinea, Angola, Mozambique).

The nodes of the international submarine cable network in Portuguese territories channeled the telegraphic traffic between several points in Europe (European regime) and between Europe and other continents (extra-European regime). The central axe of this network was the so-called "Atlantic strategic triangle": Lisbon, Cape Verde and Azores.

The construction of the Atlantic triangle was, from the beginning, not only a technical enterprise but, above all, a political, economic and financial negotiation: on the one hand Britain wanted to use Portuguese territories as the central part of its "telegraph empire", calling upon the old alliance between the two countries[5] and British strong financial power; on the other, Portugal needed to raise funds and attract foreign investors in order to implement its policy of material improvements.

The Building of the Atlantic strategic triangle

Lisbon, the apex of the Atlantic strategic triangle, was the first node to be established. In 1869, John Pender created the *Falmouth, Gibraltar and Malta Telegraph Company* to link Great Britain with the British naval bases in the

5 George Canning stated that "Portugal was, still is and will always be the best support for Great Britain in continental Europe" in *Report written by the Portuguese ambassador in London*, 16 August 1860, Lisbon, Arquivo Histórico Ministério Negócios Estrangeiros (Historical Archive of the Ministry of Foreign Affairs, hereafter cited as AHMNE) 2.º PISO, A2, M2, Lisbon.

Mediterranean, "without crossing foreign countries."[6] In that same year, and fourteen years after having received the first proposal (1855) for building a cable between Europe and the United States through the Azores, the Portuguese government finally granted a concession to build "the submarine telegraph lines that were of national interest"[7]. In 1870, *Falmouth* built and started to exploit two cables linking Portugal to Great Britain and to Gibraltar, thus protecting British interests in the Mediterranean and establishing a fast and secure connection with India. Although the initial purpose of avoiding foreign countries was not achieved, both the Ottoman and the Russian empires were indeed avoided and the inevitable Portuguese points of landing were considered absolutely reliable.

The contract with the British company was a decisive changing point in Portuguese policy for telecommunications. Until then, the state had held the exclusiveness for construction and management of the telegraph network: the transoceanic connections should be established by granting concessions to private foreign companies, but the Portuguese government would remain in charge of all the lines in Portuguese territory. Also the regulation and supervision of telegraph services, even if provided by foreign companies, were to be kept under Portuguese administration.

The contract with the *Falmouth, Gibraltar and Malta Telegraph Company*, following the rules of the International Telegraphic Convention of Paris (1865), ascribed more du-

6 Headrick, *Invisible Weapon*, 24.
7 *Diário do Governo*, 189, 25 August 1869.

ties than rights to Portugal, as the Portuguese government was obliged to zeal for the non-interruption of the international traffic.[8] The Portuguese "public interest" was satisfied not in monetary terms, as the traffic between Falmouth and Gibraltar did not pay any transit taxes for passing through Lisbon[9], but in "geopolitical money". In fact, Portugal had from now on an important alternative for its international communications, avoiding dependence on the Spanish network, which was quite embarrassing in technical terms.[10]

In the meantime, the British company kept building alternative lines that landed in other Portuguese locations, but which were all linked to the Lisbon relay station, that became one of the most important nodes in the overall network. [11]

Cape Verde was the second vertex of the Atlantic strategic triangle to be established. In 1872, the Portuguese government allowed two British companies, the *Construction and Maintenance (Telcon)* and the *Falmouth* to build a cable to link Great Britain to Brazil via Portugal and landing

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[8] The adherents to the convention were forced to guarantee technical and organisational conditions for a quick and non-interrupted service (articles 1, 2 and 3), which was recognised as a universal public right (article 4).

[9] *Report of the engineer P. B. Cabral*, AHFPC, Lisbon, Document 50, in Archive nº 3.7.2/Pr 5.93/M2, Cabos Submarinos (1886-1892). Contratos de Concessão.

[10] Probably due to the difficulties of development of the Spanish network, whose density was 3,5 times inferior to the Portuguese. See A. Calvo, "Los Inicios De Las Telecomunicaciones En España: El Telégrafo", *Revista de Historia Económica*, 3(2001), 613-635, 617.

[11] Headrick, *Invisible Weapon*, 40. "(...) the route to India was (...) handling not only Indian traffic, but also that of Australia, Southeast Asia, and parts of the Far East."

in Madeira and Cape Verde (St. Vincent).[12] Both companies were also allowed to build a cable between Cape Verde and the Western Coast of Africa.[13] In 1874, the connection with Brazil was ready, linking Great Britain to South America, and thereby improving its commercial relations with Brazil and Argentina, and giving Portugal the opportunity to link the mainland to the islands of Madeira and Cape Verde.

The construction of the Cape Verde relay station was quite a success to Portugal: it extended the Portuguese telegraph network to Madeira and to the African colonies (including both the islands and the western (1885) and eastern (1887) coasts of Africa) and it gave the Portuguese Treasury an important source of income from the transit taxes passing through Cape Verde.

The Azores were the third vertex of the Atlantic strategic triangle to be built, though it could have been the first, and it was indeed a troubled affair. By the beginning of the 1890s, the atmosphere of suspicion and tension among European nations had increased dramatically. In Portugal, the "ordinary man" felt that Portugal was being despoiled of its African colonies by the Berlin Conference agreements, by the Treaty of Congo[14] and finally by the British *ultimatum*.[15]

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12 *Diário do Governo*, 114, 22 May 1872.

13 *Diário do Governo*, 261, 18 November 1872.

14 One of the vulnerable areas was the southern part of Congo considered by the Portuguese government as national territory, but also claimed by Great Britain and Belgium. In 1884, the Portuguese and the British governments signed a peace treaty known as Treaty of Congo. However, as both Portuguese and British businessmen disapproved the treaty and the Belgium King, Leopold II, also opposed it, it was not put in practice.

In this new context, the Azores regained its strategic importance. For the first time, and as a direct consequence of the *ultimatum*, Great Britain lost its unchallenged ascendancy over the Portuguese government who was eager to show its national pride and started to consider new proposals, especially from France and Germany. Thus, the construction of the cable Lisbon-Azores-United States had two phases: the first one, between 1890 and 1893, linking Lisbon to the Azores; the second, from 1897 to 1900, linking the Azores to the United States of America.

For the first phase, the Portuguese government decided to open, in June 1890, a public competition to build up the cable between Lisbon and the Azores, at Portuguese expenses. A French company, the *Société Française des Télégraphes Sous-Marin*, won the contest, but the Portuguese catastrophic financial situation led to the cancellation of the agreement. In December 1891, the *Telcon* presented a new proposal to build up the cable between Lisbon and the Azores, Lisbon and France, and the Azores and the United States. In exchange for its investment, *Telcon* claimed the renewal of the contracts of 1870, with the *Eastern Company* (to open the Indian route) and of 1872, with the *Brazilian Company* (to open the South America route). The British cartel aimed at decreasing the effects of French competition, preventing the telegraphic traffic from being diverted from their lines to the French cables between Senegal and Brazil

[15] The *ultimatum* of January 1890 from British government to the retreat of Portuguese troops from the region between Angola and Mozambique claimed by both countries.

(Pernambuco) and from Brazil to the United States. The Portuguese government evaluated the proposal with distrust, considering that it should be revised in order to ensure the national interest, namely "the benefits coming from the geographical location of the country".[16]

In 1892, when the British proposal was still being analyzed, Portugal received a second proposal, again by the French company, which was surprisingly accepted. The decision was clearly political because the technical report was undoubtedly against the French proposal. Nevertheless, the Portuguese government kept its decision, showing to the world the national opposition and public opinion that Portugal did not bend to the British interests.

However, once again the agreement with the French company was a complete flop and the contract expired even before the first stone was laid down. In June 1893, the Portuguese government was compelled to ask the Parliament's permission for signing the contract with the British *Telcon* for building the cable Lisbon-Azores, exactly on the same bases of the proposal that had been refused one year before. The contract was signed on 17 June, and the relay stations in the Azores opened to the traffic in August.

The second phase of the cable Lisbon-Azores-United States, the construction of the cable from the Azores to the United States, was also a very difficult process. At the end of the nineteenth century, German entrepreneurs and business men wanted a more effective channel to communicate with

[16] *Cabos Submarinos (1886-1892). Contratos de Concessão AHFPC*, Lisbon, Archive, nº 3.7.1/Pr 5.93/M2.

the United States, which was then a growing market and a new world power. Like France, Germany wanted to have their own cables free from British influence and scrutiny. The British company *Europe & Azores* (the British company founded to exploit the cable), supposedly responsible for extending the cable from the Azores to the United States, confessed its financial resources were not enough to support such an expensive project and requested, in July 1897, permission to transfer the concession of the cable to a German company, the *Felten & Guilleaum*. This company had a concession from its government to lay a cable from Germany to the United States. The agreement seemed to be convenient both for the British and the Germans and, among several changes to the original contract, asked for permission to build up a direct cable between the Azores and Vigo (Spain).[17]

Portugal strongly disagreed with this proposal. According to the initial contract, *Europe & Azores* was not allowed to transfer to a third party its rights and duties. Also, as far as the American policy towards telegraphs was concerned, the fact that the German company had privileges back home was an impediment for landing cables in the United States. Apart from these juridical issues, the Portuguese administration also suspected the German company for economic and political reasons. A cable Azores-Vigo was a real threat to the Portuguese strategy: (i) the cable would divert traffic from Portugal to Spain, thus weakening the

[17] *Cabos Submarinos (1894-1899). Contratos de Concessão*, AHFPC, Lisbon, Archive n.º 3.7.1/Pr 11.16/M2...

Portuguese *status* as a preferential negotiator and threatening the crucial geopolitical and economic role of Lisbon as an international telegraph center; (ii) *Europe & Azores* would almost certainly be taken over by the German company, as it was unlikely that a company with such a short cable and scarce traffic could keep its position as a mediator between the Eastern Europe traffic and Africa via Lisbon; (iii) the maintenance of the cable between Lisbon and the Azores could be easily neglected, causing severe damages to the Portuguese telegraph network.

Moreover, there were two "hot" political questions left to be solved: on the one hand the Azores-Vigo cable would enhance the Spanish position in the world telegraph network; on the other, the well-known German zeal could interfere with the telegraph service provided by relay stations under Portuguese jurisdiction, causing diplomatic incidents.

The negotiation was dragged for almost a year and in September 1898 the Portuguese government denied the permission asked by the *Europe & Azores* to lay the cable Vigo-Azores, but accepted to alter other articles of the initial contract of 1893.

In this context the *Europe & Azores* presented a new request to transfer the concession, by asking permission to land three cables in Azores: one to New York, for the German company *Atlantische Telegraphen Gesselschaft*; a second to Canada (Canso), for the *American Commercial Cable*, and a third to Germany (Emden). This request aimed at three objectives: (i) to answer the *Commercial Cable* needs to have an additional Atlantic cable between Canada

and Great Britain, separated from the existing ones; (ii) to provide *Commercial Cable* with a direct path for the traffic from North America to South America, Africa, India, China and Australia through the connection with the cables Azores-Lisbon, Lisbon-Cape Verde-Brazil and Cape Verde-Cape Town; (iii) to establish a direct cable between Emden and New York serving the traffic between the United States and Germany, including the countries that used the German line.

The Portuguese Telegraph Administration advised the government to grant the request, pointing out its advantages: the cable Lisbon-Azores was valuable and would become a significant source of income, "without any charges for the Treasury."[18] The definitive contract was signed in December 1899,[19] imposing on the German and American companies the supervision of *Europe & Azores* that was held responsible for paying the Portuguese government the transit taxes.

At last, from 1900 onwards, Azores joined Lisbon and Cape Verde, becoming all together one of the most important crossroads on the international submarine cable networks.

The (not truly) "all-red" cables

By the turn of the century, for building a supposedly "invulnerable all-red cable", the British government relied

[18] *Cabos Submarinos (1894-1899). Contratos de Concessão*, AHFPC, Lisbon, Archive nº 3.7.1/Pr 11.16/M2.

[19] *Ibidem*.

on the depth of the ocean, and once again on Portugal to guarantee its security, since the new cable Great Britain-Cape Town-Australia still landed in Portuguese territory. The proposal presented by the *Eastern Company*, in July 1899, explicitly stated that (i) the option of landing in Madeira and Cape Verde replaced the possibility of the cable "to touch exclusively at British possessions"; (ii) the "present transit taxes for telegrams exchanged with South Africa" were ascribed to Portugal; (iii) an increase of the traffic through the "proposed new route" was expected, but in any case a minimum income estimated upon the traffic Registered in that year was ensured. In order to reinforce the proposal it was also stressed that the new route would "be declared via normal for South Africa" and Australia.[20] In spite of the urgency requested by *Eastern*, the negotiations lasted more than a year. On 22 September 1900, the contract was at last signed; the cable was completed in February 1901.

The British government tried to devaluate the fact that the new "all-red" cable was not truly "all-red", as it still landed in a foreign territory. It is therefore quite surprising that in December 1911 the Standing Subcommittee of Imperial Defense stated that the "dependence of the United Kingdom on cable stations situated upon foreign territory for the transmission of telegrams has been generally eliminated."[21] The British concept of "generally" was at least doubtful, as

[20] *Denison-Pender in a letter addressed to Madeira Pinto, General Director of the Post and Telegraphs of Portugal, dated from July 25, 1899. Cabos Submarinos (1893-1910). Contratos de Concessão*, AHFPC, Lisbon 3.7.1. Pr. 9.42/M2.

[21] Headrick, *Invisible Weapon*, 99.

the relay stations of Lisbon, Cape Verde and Azores not only were ever "eliminated", but also were in fact reinforced, as it was made clear during and after World War I.

A Shift in Power: Challenging British Leadership

On 4 August 1914, the British government ordered the disruption of the two German cables that linked Germany (Emden) to the United States (New York) via the Azores. A month later, the Portuguese authorities sealed the German station, thus interrupting the traffic between Azores and America.

On 27 September 1916, the British minister in Lisbon sent the Portuguese government a "very confidential" letter informing that his government had decided, after consulting with France, that the German cables should be fully operational again. Both cables would link Europe to Canada via the Azores: one cable going from the British coast (Porthcurno, Cornwall) to the Canadian coast of Nova Scotia (Halifax); a second cable linking the French coast (Brest) to the Canadian coast of Newfoundland (S. Pierre). Portugal would, therefore, recover an important source of income, as the British and French authorities obviously had to pay the previously agreed transit taxes. On the next day, a new letter from the British ambassador added a second request, asking the Portuguese government to allow the *Eastern Telegraph* to use the telegraphic apparatuses and the cables in stock at the relay station of Faial (Azores). Roughly six months later,

as a sign of collaboration among allies, the Portuguese government authorized the use of the cables and of the material requested by "His Majesty's Government that was anxious that the Eastern Telegraph Company at Faial should be authorized to unseal the cable (...) and to use it for communication with the United Kingdom."[22] On 18 July 1917, the cable linking Great Britain to Canada was already operational.

Meanwhile, unlike the British government, the French authorities unilaterally diverted the second German cable to Brest and from there to Canada, using the cable without paying the due telegraph taxes to Portugal corresponding to a few thousands of hundreds of francs per year.[23]

The United States of America step in

During and after World War I the use of the German cables was a very complex affair. Great Britain and France were not alone in their interest for the Azorean cables; the United States of America soon claimed their rights to use on equal terms the Atlantic strategic triangle, and in particular the Azores relay station. For the American entrepreneurs and businessmen, the Azorean link was pivotal to their expansionist agenda, since it enabled them to reach the central European markets, without being under their rivals'

[22] 3.º PISO, A1, M28, AHMNE, Lisbon.

[23] According to the estimation of Portuguese Administration of Post and Telegraphs, in 3.º PISO, A10, M101, AHMNE, Lisbon.

surveillance. The importance of the Azorean cable became even more obvious when political conflicts in Ireland interrupted the communications between the Irish coast and the United States, preventing the Americans to reach Europe.

The landing of telegraph cables in Azores was also important for technical reasons. The old American transatlantic cables which had been built without relay points were so slow that they became almost useless. The construction of submarine cables had proved that the cable length should not exceed 2000 miles, in order to assure the volume and the speed required by the transatlantic business traffic. The Azores were indispensable for the American telegraph network.

Therefore, the government of the United States decided to put an end to the British hegemony and actively engaged in a political and diplomatic battle to support the quest of American telegraph companies for European concessions. In 1919, when the American companies *Commercial Cable* and *Western Union Company* asked Portugal permission for using the Azores relay station for their new cables, the *New York Times* was particularly sarcastic when commenting on the delay of the Portuguese authorities to reply. They added that it was quite a mystery why their "fellow republicans"[24] took so long to give the official approval, and drew attention to the links that should unite the republican brotherhood against the British monarchy.

[24] "American Cables", *New York Times*, August 17, 1922.

The Portuguese answer took almost two years and a half. For the Americans it was a clear sign of the British dominant position in relation to Portugal, and of the "opposition of British companies that fear American competition (...), but American prestige makes itself felt."[25] In fact, the United States were very busy using their embassy in Lisbon and addressing the Portuguese ambassador in Washington in order to lobby for a positive reply which would finally arrive in April 1922.

The contracts established with the American companies strongly displeased the British government. On behalf of *Europe & Azores*, the British diplomat requested, only based on the "close and friendly relationship" with Portugal, "that in order to protect its South American traffic, the working of the proposed cables of the American Companies should be limited to their North American traffic."[26] This restriction was obviously against the interests of the American companies and it broke the traditional rules of telegraph concessions, by disclosing, once again, the political character of this dispute. The long-lasting service provided by Portugal to the British telegraph empire, together with the network of economic, financial and political bonds between the two nations, allowed the British government to interfere in Portuguese internal affairs and decisions.

[25] "American Cables".

[26] Note dated from June 1922, from Lancelot Carnegie, in 3.º PISO, A10, M101, AHMNE, Lisbon.

In its first note to the Portuguese dictatorship government established by a military coup in 1926,[27] the United States expressed their resentment at the way American companies had been treated by Portugal between 1919 and 1924, implying that, as far as the world telegraph network was concerned, the previous republican governments were hostage to British influence. According to this note American companies were forced to agree on the British terms due to the "inaction of the Portuguese Government (...) in view of this situation that I asked (...) whether Your Excellency thought it likely that an untrammeled landing license in the Azores would be granted an American company if it should apply for one."[28]

The American concerns regarding Portuguese sovereignty were, in fact, a pretext to assert its own national interests in the new global world. The British hegemony, largely unchallenged during almost two centuries, was now facing forceful opponents, not only the traditional ones, such as France and Germany, but also the newcomer United States of America: "Great Britain (...) must yield to the rational demands of the United States and other nations"[29]. It was clear that those who controlled the information controlled the world. In this context the Atlantic strategic triangle, one of the crucial parts in the transnational network

[27] The military coup opens a dictatorial period which will lead to the authoritarian regime of the Estado Novo (New State), a dictatorship that lasted until 1974.

[28] 12 April 1927, 3.º PISO, A10, M101, AHMNE, Lisbon.

[29] "Warns of British Control of Cables. Walters S. Rogers Urges That the Azores Be Made Free Landing Stations", *New York Times*, August 16, 1922.

of telegraph, had to be considered a "free zone", available to all countries willing to negotiate with the Portuguese government.

German and Italian cables to the United States

Besides the British, the German (*Deutsch Atlantische Telegraphengesellschaft* succeeded to get a new concession form the Portuguese Government), the French (through *Commercial Cable*) and the Americans, a fifth country was willing to enter the telegraphic competition: Italy. In August 1923, during the difficult process of negotiation between Portugal and the American telegraph companies (under the surveillance of Great Britain), the Italian government informed the Portuguese counterpart that the difficulties raised by Portugal to the *Western Union* project of landing a cable in Azores were intolerable. The Italians already knew that the British government opposed the American project, claiming that its interests would be damaged. Moreover, the Italians also wanted to build up their own cables lines, namely between Italy and South America. In April 1921, the Italian company *Italcable* asked permission for landing cables in Cape Verde; as usual the negotiations were not easy and in November 1923, the representative of *Italcable* came to Lisbon to try to settle an agreement. In the meantime, *Italcable* bought the rights of the cable Azores-Malaga-Italy from the *Western Union Company*. In July 1925, the Italian company tried to build the connection between Azores and Cape Verde that had already been granted in the previous

year[30]. This cable would encircle with Italian cables the Atlantic strategic triangle (Lisbon-Azores-Cape Verde), until then exclusively British. However, instead of the cable Lisbon-Azores, Portugal gave its permission to a cable Italy-Azores in order to prevent the Atlantic triangle from being closed with Italian cables, and in this way promote the channeling of new traffic to Azores, thereby maximizing income to the Portuguese Treasury.

Later on, *Italcable* made a new proposal to build up a cable between Lisbon and northern Europe. This time, the British government reacted violently, complaining that it had not been informed nor heard on this matter. Following Chamberlain's direct instructions, a note from the British embassy in Lisbon stated that "His Majesty's Government feel bound to place on record their regret that this omission should have occurred and they confidently expect that the Portuguese Government will adhere in future strictly to their undertaking that no concessions or other facilities in Portuguese Atlantic ports will be granted to a foreign power without previous consultation with them."[31] The terms used in this diplomatic note are quite harsh, showing that the British government would not tolerate any Portuguese attempts to define its own independent strategy.

[30] *Diário do Governo*, 10 April 1924.

[31] Note dated from 1 September 1927, from Grant Watson, 3.º PISO, A10, M132, Pr. Nº 296/21, AHMNE, Lisbon.

Was Portugal a Loser or a Winner throughout this process?

The fact that all participants of a transnational technological network, such as the telegraph, may profit from its presence in the network does not mean that all of them have the same negotiating status. Economic and political hierarchies extended their influence upon the technological world: a peripheral country such as Portugal could not stand against Britain's interests, would thus it become a loser? In fact, it is quite clear that the Portuguese policy concerning telegraph cables was always determined by British interests.

But the dominance of the British cable network depended on foreign territories and Portugal was almost the ideal ally: (i) the Portuguese mainland offered good conditions for landing the telegraph cables; (ii) Portugal had two archipelagos (Azores and Madeira) in the Atlantic Ocean, between Europe and America, with an excellent location for landing intermediate cables; (iii) Portugal had a large African colonial empire, including islands and territories in the western and eastern coasts of Africa, also available for telegraph cables; (iv) Portugal was a trustful country, politically quite stable; (v) Portugal needed foreign investments to develop a policy of material improvements; (vi) Portugal couldn't negotiate in equal terms with Great Britain.

In addition, Portugal profited from the alliance with Great Britain by using the technical resources provided by the British telegraph network of cables to manage and control its empire. In fact, Portugal took advantage of its host role at different levels: (i) at the economic and financial

level, because the Portuguese government, engaged in a policy of material improvements, did not have to ask for more loans to build its own telegraph network; on the contrary, it received a considerable income for owning telegraph infrastructures which had been built free of charges; (II) at the political level, because the telegraph network allowed Portugal to establish links to all its colonies, and therefore to assert its role as a colonial nation, not only in the African arena, but also in the European scene; moreover, together with the railways the telegraph network was one of the most effective tools for building a modern country, both on the mainland and in the colonies; (III) at the technical level, because there was a transfer of technology not only concerning the apparatuses, but also in terms of expertise both at an intermediate level and a higher level (engineers).

Thus, beneath this apparently "plain surface" of British domination we find a much more rich reality. At first glance, Portugal may seem a loser, but behind the servility there was a hidden political agenda, crucial to the Portuguese strategy of development. In this context, a new type of a winner-loser scenario can be envisaged: by hosting the British cables and the British plans for controlling the telegraph, Portugal was able to secure its position as a partner in the transnational cable network and thus avoid deepening its peripheral status in the European arena.

reviews

James A. Secord, *Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation* (Chicago / London: The University of Chicago Press, 2000)..

By Bernadette Bensaude-Vincent [*]

Although it came out in 2000, James Secord's *Victorian Sensation* still deserves a review because it is a case study written as a manifesto for a different kind of history, comparable to the publication of *Leviathan and the Air-Pump* published in 1986. Whereas Shapin and Schaffer promoted the social studies of science in describing a connection between scientific knowledge and political thought, Secord advocates the history of the book and reading.

Victorian Sensation is a kind of biographical account of a book, which was one of the most controversial best-sellers of the nineteenth century.

Vestiges of the Natural History of Creation was anonymously published in 1844 and went through eleven of

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its twelve editions before the author's name was unveiled. It has been translated in German, Dutch and went through twenty editions in the United States. *Vestiges* caused a great commotion in the Victorian society as it raised intense public debates in the 1840s. Secord argues that the controversy about creation versus natural laws was not raised by Darwin's *Origin of Species* in 1859. Rather Darwin's *Origin* was dropped "into a saturated solution like a crystal around which all diverse elements coalesced" (p. 522). The so-called Darwinian revolution was prepared by the anonymous *Vestiges*.

Despite this strong claim, Secord's study is not meant to provide an additional account of the controversies around Darwinism. Historians exclusively interested in scientific doctrines were extremely disappointed because they learnt nothing about the contents of *Vestiges*. For instance the review by Arianne Chernock in the *New York Times* (May 20, 2001) concluded: "Unfortunately, another book on "Vestiges" itself rather than this intelligent analysis of its production and reception is needed to determine whether Secord's argument here is well founded". Had Secord's main goal been to demonstrate that *Vestiges* should be taken into account as a precursor of Darwin, he would have followed the usual pattern: describing its contents and context of publication, then its reception. Instead the only information provided by Secord is that *Vestiges* was an ambitious narrative tackling the big questions, from the formation of the solar system to the formation of the human species as descendent of apes. So if *Victorian Sensation* is not a book about evolutionary doctrines, what is it about?

Secord takes *Vestiges* as a field to experiment a new approach to the history of science. His aim is "to see what happens when a major episode is approached from the perspective of reading" (p. 518). For this purpose he explored a considerable volume of sources ranging from book reviews, diaries, correspondence, publisher's archives, conversations at the Geological Society and the British Association for the Advancement of Science... He borrowed methods and concepts from literary critics, cultural history and the history of book pioneered by Roger Chartier. The result is fascinating since the 'exercise' opens promising avenues of research and demonstrates how our standard practices of history of science distort the past. Let me retain here three major historiographical lessons:

The first one concerns the materiality of books. Secord convincingly argues that the material form of books greatly determines its meaning. The paper used, the number of illustrations, the binding and the prize of the book, as well as the railways network available for their distribution are integral to its reception. The book is the product of the publisher as much as of its author. The present case study is extremely relevant to make the point since the anonymous writer proved to be Robert Chambers, a famous publisher of popular books.

The second lesson concerns the creative role of reading. As he approaches *Vestiges* through the eyes of its readers and displays its various interpretations, Secord argues that the meaning of a book is not given by its author. The printed matters never carry stable and fixed messages that would be delivered everywhere. Readers are free to

make what they want out of books. The interpretive role of reading has been usually emphasized for literary texts, fictions and poetry. Secord argues that even the meaning of scientific books, which are supposed to objectively reflect nature is also constructed by their readers. Furthermore Secord argues that not only readers create the meaning of the book, but their reading is not "socially constructed". Readers of texts are not just reflecting the local context of reading nor are they just reinforcing existing attitudes. Reading is a subversive activity, raising questions and crossing all conventional boundaries. This is a daunting conclusion with far reaching consequences. In particular authors are not fully responsible for their writings since books can be the ferment of revolutions despite their own intentions. Secord also emphasizes that historians should not use the notion of Victorian society or Victorian mentality because there is no uniform view or stereotype. It is misleading because in various contexts people built up very different views of the progress of mankind out of the same book. In this respect the various interpretations of a best seller could be used as indicators or ideological markers of social groups.

The third lesson that I would like to emphasize concerns the attention to genres in scientific literature. Historians of Darwinism usually mention *Vestiges* as a popular book advocating evolutionary views on a vague and week basis, whereas Darwin's *Origin* belongs to technical scientific literature. As a consequence Darwin is the revolutionary hero while Chambers's *Vestiges* is mentioned as a failed attempt to establish a law-bound view of the

evolution. One major merit of Secord's case study is to demonstrate that this standard view has been shaped by Darwin himself and feeds the cult of the revolutionary hero. It is only when the identity of the author of *Vestiges* was known that the book has been dismissed as "popular" and "amateurish". Rather than taking for granted that *Vestiges* belongs to the genre of popular science and *The origins of species* to academic publications, Secord argues that this divide was the outcome of the debates about evolution. Huxley's and Darwin's dismissive evaluations of *Vestiges* helped establish the divide between professional and amateur practices of science. In Secord's view, Darwin's *Origin of Species* was not the origin of a crisis, rather it resolved the tensions raised by the impressive amount of scientific literature that flooded the market during the controversy raised by *Vestiges*." The triumph of Darwinism was not one of doctrine – there was no consensus, neither about the meaning of evolution nor of the truth of natural selection. Rather, Darwinism was a convenient label for an arena of public discussion, structured by new relations between professional science and professional journalism". (p. 514) In my view, the phrase "professional journalism" may be a bit anachronistic since professional science journalism only emerged in the 1920s. However it does not affect the relevance of Secord's argument. As historians of science, we should pay more attention to the whole spectrum of scientific literature without adopting the hierarchical categories that came to prevail. Popular narratives and elementary textbooks are as important sources as research articles for understanding scientific revolutions. As the

construction of a hierarchy of publications plays a key role in the validation of scientific claims it should be integral part in the history of scientific discoveries. Finally, Secord's emphasis on the construction of literary genres in scientific publications sheds new light on the mechanisms at work in the manufacture of scientific heroes. To be sure there are many contributions on the construction of founder myths in science and the heroic images of famous scientists – such as Descartes, Newton, Lavoisier, Faraday, Pasteur... However such studies at the borderline between the history of science and the history of ideas would greatly benefit from Secord's attention to the construction of a hierarchy of values embodied in the materiality of books.

Ana Simões, Maria Paula Diogo, Ana Carneiro, *Cidadão do Mundo. Uma Biografia Científica do Abade Correia da Serra* (Porto: Porto Editora, 2006.), pp. V+185.

By José Luís Cardoso[*]

The scarcity of biographies of relevant characters of Portuguese history has been widely acknowledged. However, from the sorrows often expressed on the apparent lack of inclination of Portuguese historiography towards the biographic genre, a recent but promising tradition of portrayals

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and biographies of figures that marked Portuguese political and cultural life has finally emerged. The present book is one example, but it widens the scope of recent Portuguese biography by focussing on the life of a person whose merit derives, above all, from his contributions to science.

The life and work of José Correia da Serra (1751-1823) offer multiple reasons and pretexts for a biography. Citizen of the world (as written in the expressive title), traveller and pilgrim, man of science and culture, political refugee and diplomat, regular presence in *salons*, little inclined to Church rituals and duties, the life of the Abbé Correia da Serra is an epitome of his time; a time marked by significant events through which one can reach a deeper understanding of the evolution of Portuguese society, and especially of the construction of science at the end of the eighteenth and early nineteenth century.

The book begins with a brief historiographic overview in which the authors revisit and analyse critically the extant literature on the life and work of Correia da Serra. In this review they take the opportunity to outline their aims and methodological orientations by clearly stating their options within history of science. Their purpose is to analyse Correia da Serra's scientific legacy by focussing, not only on the content of his scientific contributions – concepts, instruments and approaches –, but also on the various contexts, environments, languages, institutions and people; in short, the world which renders historically intelligible Correia da Serra's scientific enterprise. It is thus essential to bear in mind the limitations and stimuli to the creation and diffusion of scientific knowledge in Portugal as the authors aim at

'showing the relevance of this case to the growing awareness of one aspect of eighteenth-century Portugal in the wider scope of the study of local contexts in clarifying the pluralism of appropriation of the sciences, which have always taken place in the European peripheries.' (p.12)

The chapters proceed at the chronological pace of the places where Correia da Serra lived, or visited, the influences he received, the contacts he established, the work he produced, the institutions he attended.

His trajectory began in Italy between 1757 and 1777. Those were the years spent in Naples and Rome where he was educated and influenced by one of the Portuguese illuminati then residing in Italy, Luís António Verney. Equally important were his direct contact with Genovesi, especially relevant to the understanding of the economy of the natural world, and the epistolary exchanges with Linnaeus, an early sign of Correia da Serra's scientific inclinations.

His return to Lisbon where he lived from 1777 and 1795 was marked by his contribution to the foundation of the Lisbon Academy of Sciences, in whose early activities he participated with remarkable energy and organizational ability, and by establishing a network of national and international scientific contacts essential to his future career. His initial scientific contributions to geology and botany date from this period, as well as his methodological reflections on the utility of science.

For political reasons not yet totally clear – the protection he gave to the French Girondist Broussonet does not seem enough to accuse him – Correa da Serra sought refuge in London, from 1795 to 1801. The British capital provided

the conditions for his accumulated knowledge to blossom. He participated in the activities and publications of the *Royal Society* and of the *Linnean Society*, and established a close relationship with Joseph Banks. Correia da Serra's knowledge and the modernity of his thinking are unveiled in his most famous botanical investigations on the sex of algae and the reproduction of *Cryptogamia*.

His publications on botany, the establishment of a network of friendships and his participation in the networks of academic sociability proceed in the next stops of his itinerary, first in Paris, between 1801 and 1812, and in the USA, from 1812 to 1820, where he held the position of Portuguese diplomatic representative. His friendship with Jefferson and his involvement in teaching in the recently created Universities of Philadelphia and Virginia are salient features of the American period.

Back to Portugal in 1820, following the Liberal Revolution, Correia da Serra was to die in 1823, without his fellow countrymen recognizing the international dimension of his scientific legacy.

It is precisely this legacy, which constitutes the central axis of the biography written by Ana Simões, Maria Paula Diogo and Ana Carneiro. By resorting to the existing literature and to unpublished sources kept in national and foreign libraries and archives, the authors' pleasant writing accessible to a non-specialized audience take the readers through the eighteenth-century paths of scientific observation and experimentation, and to Correia da Serra's engagement in sharing, disseminating and appropriating knowledge.

Like the science practiced by Correia da Serra this book is useful and necessary. It is a decisive contribution, which promotes and dignifies the history of science in Portugal.

Lorraine Daston, ed., *Things that Talk. Object Lessons from Art and Science* (New York: Zone Books, 2004). 447 pp.

By Palmira Costa[*]

Things that Talk: Object Lessons from Art and Science is the result of a collaboration between a group of historians of art and historians of science that met at the Max Planck Institute for the History of Science over the course of the academic year 2001-2002. The common core of the project was to take materiality as a serious challenge and as an excellent opportunity to reflect on the various and interlocked meanings of materiality and culture. If materiality has always been of crucial importance for historians of art, only recently has it received due attention from historians of science. In part, this volume belongs to this recent historiographic trend in the history of science. It can also be associated with the burgeoning interest in

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intersections between the arts and the sciences. Some of the essays presented in the volume, share also methodological affinities with recent studies of "science in context" which emphasize the local character and cultural specificity of natural knowledge.

However, *Things that Talk* is unique in many ways. Indeed, it might be said that it is as unique, enigmatic and provocative as the things that are the object of each of its nine essays: Hieronymous Boch´s drawing *The Treeman*, the eighteenth-century freestanding column, Peacock Island in the Prussian river Havel, soap bubbles, early photographs entered as courtroom evidence, the Glass Flowers at Harvard, Rorschach blots, newspaper clippings, and paintings by Jackson Pollock as seen by the critic Clement Greenberg. Why these things and not others? The diversity and arbitrariness of this list is explicitly assumed by the editor in her excellent introduction. Nevertheless, are there things that by their very nature talk more than others? According to the editor and the contributors, these are the things that have a composite and ambiguous nature, that are more resistant to classification and to interpretation, things that through their striking properties embody loquaciousness. Yet, is their talkativeness obvious and easy to decipher? The meticulous, detailed and sometimes dense accounts presented in the book, all written by well established scholars in their fields, testify to the contrary. It is the proposition of the book that certain kinds of things talk for themselves. However, the work itself is also proof that these things need privileged mediators in order to be properly heard by most people who care about what they might "say".

As the subtitle indicates, the volume is a series of object lessons. Do they all succeed in their pedagogical aim? Although all of the essays might be inspiring in one way or another, they do not share the same clarity, elegance, and captivating qualities. Besides, illustrations have an important role in the analysis and argumentative strategies presented in the various essays but except for the nine colour plates, their reduced size and poor quality sometimes makes it difficult to follow the argument.

It is inevitably difficult to do justice to such a diverse collection in a short review so I will focus upon three of the contributions that are not only more interesting to historians of science, but also excel in their instructive and engaging qualities. M. Norton and Elaine M. Wise's "Staging an Empire" presents the changing fortunes of the Peacock Island in the Havel River near Potsdam between 1793 and 1830. This very well documented essay takes us into the multiple layers of meaning that have been built into the island and that range from visions of romantic isolation, imperial fantasy, and industrial and colonial development. Simon Schaffer's "Soap Bubbles in Classical Physics", provides us with a fascinating account of how soap bubbles, commercial commodities associated with hygiene and purity as well as artistic and moral systems of innocence and transience, were also crucial objects in scientific studies and public demonstrations of Classical Physics during the final decades of the nineteenth century. Finally, Lorraine Daston's delightful essay, "The Glass Flowers" focuses on the collection of 847 lifelike models of over 750 species and varieties of plants held at the Harvard Museum of Natural History. It shows us

how things can be made to talk out of love as well as hatred since the virtuosity and accuracy of the glass flowers made them not only objects of admiration on the part of both scientists, patrons, curators and the general public, but also objects of suspicion by some scientists who viewed them as unscientific. It also illustrates how they changed their status from scientific glass models into public wonders.

Overall, *Things that Talk is* a stimulating work that reveals the fluidity and inner structures of meaning associated with materiality. Yet its thematic and methodological variety makes it a somewhat disconcerting and puzzling collection of new "things" that talk.

Isabel Amaral, *A Emergência da Bioquímica em Portugal: As Escolas de Investigaçâo de Marck Athias e de Kurt Jacobsohn* (Porto, Fundaçao Calouste Gulbenkian- Fundaçao para a Ciência e a Tecnologia, 2006). ISBN: 972-31-1149-7.

By José Ramón Bertomeu Sánchez [*]

The book analyses the emergence of biochemistry in Portugal throughout a comparison of the two main research schools headed by Marck Athias (1875-1946) and Kurt Jacobsohn (1904-1991). Research schools became very

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important in nineteenth-century and twentieth-century science and the focus of many historical studies during the last three decades. Many important books and papers had been published on the research schools lead by Pasteur (Gerald L. Geison), Thomson (Jack Morrell), Liebig (Frederic L. Holmes, Joseph Fruton), Wurtz (Ana Carneiro), Dumas (Leo Klosterman), etc. Research schools can be defined as "small groups of mature scientists pursuing a reasonably coherent program of research side-by-side with advanced students in the same institutional context" (Geison, 1981). Thus, when studying research schools, historians have to pay attention not only to the life and scientific contributions of their leaders, but also to their disciples and collaborators (whose biographies are sometimes very difficult to reconstruct); the laboratories and the educative and research centers, in which a collective research program was developed; and, last but not least, the relationship with other research groups and the economic and political powers, which make possible the due funding and institutional support. Before discussing these issues, Isabel Amaral reviews the emergence of biochemistry as a discipline in the international context. Special attention is paid to the German and British cases. In Germany, biochemistry emerged from two different experimental cultures (organic chemistry and experimental physiology) while in Britain the origins are found in medicine and physiology. The main part of the thesis is the analysis of the mentioned two research schools, which, roughly speaking, mirror the mentioned paths of institutionalization of biochemistry: medicine (Marck Athias) and organic chemistry (Jacobsohn). Apart from the

research program, the differences between the schools included the biographical profile of the leaders and main collaborators, and the institutional setting. Marck Athias was born in the Madeira Island and studied in Portugal and France, while Kurt Jacobsohn was born in Germany and his early career was spent at the prestigious *Kaiser Wilhelm Institut für Biochemie* (Berlin). In 1929, he obtained a four-year position in the recently created *Instituto Rocha Cabral* (IRC), a Portuguese version of the Rockefeller Institution, in which Jacobsohn developed his research for the rest of his life. In contrast, Marck Athias's headquarters were placed at the Faculty of Medicine of Lisbon University, even if he and his group also worked in other centers. Marck Athias's research was focused on normal and pathological histology, while Kurt Jacobson's research was centered on enzymes kinetics and enzymology in general. The mentioned topics were important in the development of their disciples' careers but from different points of view in each case. When describing the disciples of Athias, Isabel Amaral distinguishes three different groups: the "central core" (those who worked in the same topics and in the same institutions for long periods); those who were trained along the lines of research and developed them in other institutions; and, finally, the temporary collaborators, that is, those for whom the work with Athias was just a temporary stage in their careers. Athias and the disciples of the first group are similar to other studied research schools: their training in experimental methods took place in the laboratories of the group; they followed similar publication patterns and they became influential members of crucial research institutions

and societies somehow related to the main research topics: histology and physiological chemistry. According to Isabel Amaral, that was not the case of Jacobson's disciples, whose collective characteristics fit better in what Joseph Fruton has called a "research group", that is, "scientists who achieved sufficient recognition to allow them to conduct an independent research program". Amaral includes not only Jacobson's direct collaborators and disciples but also the members of the IRC Physiology department and other temporary collaborators. The bulk of biographical and bibliographical data gathered about the two groups is amazing but it is a pity the lack of a list of names and institutions.

Thus, the book touches three current important historiographical issues: the emergence of disciplines, research schools and scientific peripheries. The emergence of disciplines and specialties has been analyzed by many historians but mostly focusing on countries such as France, Germany, Britain or USA, as the recent book by George Weisz clearly shows (*Divide and Conquer: a comparative history of medical specialization* (Oxford University Press, 2006)). The same situation applies to research schools. The book by Isabel Amaral enlarges the sample by adding two active research schools working outside the main European scientific centers. Many of these questions are discussed by Isabel Amaral thanks to a large amount of almost unknown sources (mostly papers, more than 600 are listed), which had been recovered and analyzed. Other sources (laboratory notebooks, archival documents, letters, material culture, etc.) are lacking, so the study also shows how much remains

to be done in order to guarantee the preservation of the memory of contemporary science. By showing the relevance of the studied schools, Amaral has made an important contribution in that sense. Moreover, the book offers avenues for future comparative studies with other similar cases in the scientific periphery, notably in the Iberian contexts. The role of the Nobel Prize Santiago Ramón y Cajal and the political circumstances (dictatorships) are just two examples. In conclusion, the book will be a fruitful reading for those interested in broadening their views on the emergence of disciplines and research schools.

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